## *United States Court of Appeals*
## *for the*
## *District of Columbia Circuit*

# TRANSCRIPT OF RECORD

# TRANSCRIPT OF RECORD

---

## United States Court of Appeals for the District of Columbia

APRIL TERM, 1939.

**No. 7380**

447

---

ARNOLD POULSEN, AND AXEL CARL GEORG
PETERSEN, APPELLANTS,

*vs.*

CONWAY P. COE, COMMISSIONER OF PATENTS.

---

APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR
THE DISTRICT OF COLUMBIA.

---

**FILED APRIL 4, 1939**

**PRINTED JUNE 5, 1939**

# United States Court of Appeals for the District of Columbia

## APRIL TERM, 1939.

## No. 7380

---

ARNOLD POULSEN, AND AXEL CARL GEORG PETERSEN, APPELLANTS,

*vs.*

CONWAY P. COE, COMMISSIONER OF PATENTS, APPELLEE.

---

APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA.

---

INDEX

| | Original | Print |
|---|---|---|
| Caption | a | 1 |
| Bill | 1 | 1 |
| Answer to the bill of complaint | 9 | 7 |
| Stipulation as to file wrapper, &c. | 12 | 9 |
| Condensation of file wrapper and contents of application for patent, Serial No. 563,447 | 13 | 10 |
| Plaintiffs' evidence | 90 | 77 |
| Exhibit 1 | 158 | 116 |
| Exhibit 2 | 159 | 117 |
| Exhibit 3 | 160 | 118 |
| Findings of fact | 161 | 119 |
| Conclusions of law | 164 | 122 |
| Final judgment | 166 | 123 |
| Notice of appeal | 167 | 123 |
| Memorandum: Bond on appeal for $250.00—filed | 167 | 124 |
| Points to be relied upon on appeal | 168 | 124 |
| Designation of recard on appeal | 170 | 125 |
| Stipulation as to designation | 171 | 126 |
| Stipulation as to opening statements of attorneys | 172 | 126 |
| Clerk's certificate | 173 | 127 |

# United States Court of Appeals for the District of Columbia

---

a. District Court of the United States for the District of Columbia

In Equity No. 64497

ARNOLD POULSEN, AND AXEL CARL GEORG PETERSEN, *plaintiffs*,

vs.

CONWAY P. COE, Commissioner of Patents, *defendant*.

UNITED STATES OF AMERICA,
*District of Columbia, ss:*

BE IT REMEMBERED, that in the District Court of the United States for the District of Columbia, at the City of Washington, in said District, at the times hereinafter mentioned, the following papers were filed and proceedings had, in the above-entitled cause, to wit:

1 *Bill*

Filed May 20 1937

In the District Court of the United States for the District of Columbia

In Equity No. 64497

ARNOLD POULSEN, of 7 Hoyrups Allé, Hellerup, Copenhagen, Denmark, and AXEL CARL GEORG PETERSEN, of 183 Norrebrogade, Copenhagen, Denmark, *plaintiffs*,

vs.

CONWAY P. COE, Commissioner of Patents, *defendant*.

*The Plaintiffs State as follows:*

(1) Both plaintiffs are subjects of the King of Denmark and residents of Copenhagen, Denmark, their post office addresses being, respectively, 7 Hoyrups Allé, Hellerup, Copenhagen, Denmark, & 183 Norrebrogade, Copenhagen,

Denmark; they are the joint inventors and applicants for the patent, the refusal to grant which by the Commissioner of Patents, is the basis of this suit.

(2) The defendant, Conway P. Coe, is the Commissioner of Patents of the United States, a legal resident of the District of Columbia, and is sued as Commissioner of Patents of the United States.

(3) The jurisdiction of this court depends upon the patent laws and particularly Title 35, Sections 31, 59a and 63 of the Code of the Laws of the United States of America (Revised Statues 4886, 4911 & 4915).

2 (4) That heretofore and prior to September 17, 1931, said plaintiffs were and still are within the meaning of the Statutes of the United States then in force, the first, original and joint inventors or discoverers of certain new and useful improvements in Reproduction Film for Reproduction of Sound and Process for Recording the Sound, not known or used by others in this country before their invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country before their invention or discovery thereof, or more than two years prior to their application for United States Letters Patent therefor, hereinafter identified, and not in public use or on sale in this country for more than two years prior to said application, and not first patented in any foreign country by them or their legal representatives or assigns on an application filed more than twelve months prior to the filing of their said application for United States patent, and that the same was not abandoned.

(5) That on December 17, 1931, the said plaintiffs duly filed an application in writing in the United States Patent Office for the grant of Letters Patent upon the said invention, said application bearing Serial No. 563,447, said application having been prepared and filed in accordance with the laws of the United States and the rules of the Patent Office, and that all fees therefor and in connection therewith provided for in the patent laws were duly paid.

(6) That the said application Serial No. 563,447, since
the same was filed was, and has been, duly prose-
3 cuted in accordance with the laws of the United
States and the rules of the Patent Office.

(7) That the said application was passed upon by the Primary Examiner of the Patent Office, who refused to allow the application and to allow the following claims in this said application, ultimately rejecting said claims finally in accordance with the practice established by the rules of the Patent Office in such cases:

49. An apparatus for producing a photographic sound record of the variable width type comprising means for directing a beam of light onto a moving film so as to form a transversely disposed narrow strip of light on the film, means actuated by a sound responsive current for varying the length of the strip of light in accordance with the amplitude of the sound, a thermionic tube arranged so that its plate current actuates light varying means, means for applying a biasing potential to the grid of said tube, means actuated by a rectified portion of the sound responsive current for controlling said biasing potential in accordance with the volume of the sound so as to cause the plate current of the tube to vary in accordance with the volume of the sound, the apparatus being so adjusted that the zero line of the sound trace takes up such an initial position relatively to the sound track that, when the plate current attains a zero value, the zero line moves from the said initial position into the center line of the sound track, said apparatus including an oscillograph for directing the beam of light onto the film and for swinging the beam in accordance with the amplitude of the sound, in which the loop of the moving system of the oscillograph is connected in the plate circuit of the thermionic tube in series with two ohmic or inductive resistances, which are arranged one on each side of the loop, with a condenser connected across the said resistances and the loop, in order to prevent current of audible frequencies in the plate circuit from affecting the mean position of the moving system of the oscillograph.

70. A system for recording sounds on a light-sensitive film comprising means for converting sounds into an alternating current, a light source, means to concentrate a beam of light from said light source onto the surface of the film so as to form thereon a transversely disposed linear strip of light, means to cause the exposure of the film to vary in accordance with the alternating current, a rectifier rectifying a portion of said alternating current, and a

4 smoothing circuit through which the rectified current influences said sound recording means to cause the exposure to vary dependent on the volume of sound, the electrical constants of the rectifier and said smoothing circuit being so adjusted that the time constant of the total rectifying circuit is of smaller value when the rectifier is operative than when it is inoperative.

72. The method of producing a photographic sound record comprising the following steps: directing a light beam onto a moving film so that it receive a transversely disposed extremely narrow strip of light, variably exposing the film in accordance with the amplitude of each individual sound wave, controlling the light impinging on the film to vary the average exposure of the film as the volume of the sound to be recorded varies, and holding the variations of the average exposure between predetermined lower and upper limits.

73. The method according to claim 72 and in which the lower limit of the average exposure variation is approximately zero.

74. The method acccording to claim 72 and in which the upper limit of the average exposure variation is substantially midway between zero and full exposure.

76. In a photographic sound recording system including a moving film, a source of light and a light flux controlling element, sound modulated alternating current means for controlling said element to expose the film in accordance with the amplitude of each individual sound wave, and biasing means for controlling said element to vary the average exposure of the film between a predetermined lower and a predetermined upper limit.

77. The recording system according to claim 76 and in which the lower limit is approximately zero.

78. The recording system according to claim 76 and in which the upper limit is substantially midway between zero and full exposure.

79. The recording system according to claim 76 and in which a source of unidirectional current applies a constant bias on said element, and means for applying a rectified portion of the alternating current to reduce the bias substantially to zero as the sound volume increases from zero to a predetermined maximum.

(8) That the said applicants duly appealed from the decision of the Primary Examiner to the Board of Appeals within the time and in the manner authorized by the patent laws and the Patent Office rules.

(9) That said Board of Appeals heard said appeal
5 on February 24, 1937, affirmed the rejection by the Primary Examiner of each and every one of the foregoing claims as set forth in Paragraph (7).

(10) That on May 8, 1937, the said plaintiffs petitioned said Board of Appeals for a rehearing, and that a claim be allowed to plaintiffs in said application that combines all the elements cited in claims 72, 73 and 74, and also a claim containing all the limitations of claims 76, 77 and 78.

(11) That said Board of Appeals on May 14, 1937, denied said petition for a rehearing and refused to modify its said decision.

(12) That no appeal has been taken from the said decision of the Board of Appeals to the United States Court of Customs and Patent Appeals and no such appeal is pending or has been decided, and that the plaintiffs accordingly have the right to file this bill in equity under Title 35, Section 63, as amended, of the Code of the Laws of the United States of America (R. S. 4915).

(13) That the Commissioner of Patents, by the Board of Appeals, contended that said claims 49, 72, 73, 74, 76, 77, 78 and 79 are not patentably distinguished from the normal operation of the patents to Hanna, No. 1,888,724; Robinson, No. 1,854,159; and Hewlett, No. 1,853,812, and that claim 70 fails to point out the invention because it is vague and indefinite to the extent that the invention is not particularly pointed out and defined.

6 (14) That the Commissioner of Patents, by the Board of Appeals, in denying the petition for a rehearing, contended that claims 73 and 74 if rewritten to include claim 72, would not be allowable because the additional features comprised adjustment of the devices of claim 72, and that a claim containing all the limitations of claims 76, 77 and 78 would similarly not be patentable.

(15) That the plaintiffs disagree with each of the contentions of the Commissioner of Patents set forth in the holdings of the Commissioner of Patents by said Board of Appeals to the extent to which such holdings are adverse to

plaintiffs' right to a patent on said application Serial No. 563,447; that the references of record do not anticipate plaintiffs' invention and in no wise negative the patentability of the claims which they have made and presented, and that none of the claims is vague or indefinite; that the invention was clearly unobvious and the result of an exercising of the inventive faculties beyond the province of one merely skilled in the art.

(16) That the subject matter of said application Serial No. 563,447 is of great importance and value to the trade and commerce of the United States and that said application was the culmination of intensive labor and effort, and for the first time disclosed and set forth the solution of a long-standing problem.

Wherefore the Plaintiffs pray that this Honorable Court may adjudge that they are entitled according to law to receive a patent for their invention as specified in their
7 claims, or for such part thereof, or such other and modified claims as upon hearing the Court may find to be patentable, or as the facts in the case may appear, and that this Honorable Court may authorize and direct the Commissioner of Patents to issue such patent to the plaintiffs, Arnold Poulsen and Axel Carl Georg Petersen; that a writ of subpoena be issued out of this court directed to said Conway P. Coe, Commissioner of Patents, commanding him to appear and answer this bill of complaint; and that the court grant unto these plaintiffs such other and further relief as the court may deem just.

ARNOLD POULSEN and
AXEL CARL GEORG PETERSEN
By PAUL KOLISCH
*Their Attorney*

RALPH B. STEWART,
*Solicitor for Plaintiffs*

PAUL KOLISCH
*Of Counsel*

STATE OF NEW YORK,
*County of New York, ss.*

Paul Kolisch, being duly sworn, deposes and says that he is the attorney for plaintiffs herein; that he has read the foregoing complaint and knows the contents thereof and that the same is true to his own knowledge except as to the matters therein stated to be alleged on information and belief, and that as to those matters he believes it to be true.

PAUL KOLISCH

8 Sworn to before me this 19th day of May, 1937.

NANON E. TUTHILL
(Notarial Seal) Notary Public

Notary Public, Kings County No. 95
Certificate filed in N. Y. Co. No. 256
Commission expires March 30, 1938

---

## 9 *Answer to the Bill of Complaint*

Filed May 28, 1937

* * *

To the Honorable the Judges of the District Court of the United States for the District of Columbia.

Conway P. Coe, Commissioner of Patents, defendant herein, in answer to the bill of complaint alleges on information and belief as follows:

1. He admits the allegations that plaintiffs are subjects of the King of Denmark and reside in Denmark.

2. He admits the allegation of his official position but avers that while he has his official residence in the District of Columbia, his legal residence is in the State of Maryland.

3. He admits the allegation of jurisdiction under Section 4915 R. S. (35 U. S. C. 63.)

4. He admits that the plaintiffs, claiming to be the first, original and joint inventors of improvements in Reproduction Film for Reproduction of Sound and Process for Recording the Sound, made, in an application for patent on said alleged improvements, averments corresponding to the allegations of paragraph 4, but denies that these averments are sufficient to justify the allowance to plaintiffs of a patent containing claims 49, 70, 72, 73, 74, 76, 77, 78 and 79, as set out in paragraph 7 of the bill.

5. He admits that plaintiffs filed an application for patent on September 17, 1931, which application was given Serial No. 563,447.

6. He admits that the said application was duly prosecuted.

10 7. He admits that claims 49, 70, 72, 73, 74, 76, 77, 78 and 79, as set out in paragraph 7 of the bill, were finally rejected by the primary examiner.

8. He admits that an appeal was taken from that action of the primary examiner to the Board of Appeals.

9. He admits that the Board of Appeals of the Patent Office affirmed the action of the primary examiner.

10. He admits that a petition for rehearing was filed.

11. He admits that the Board of Appeals denied the petition for rehearing and refused to modify its decision.

12. He admits that no appeal was taken from the decision of the Board of Appeals affirming the action of the primary examiner.

13. He admits the allegations of paragraph 13.

14. He admits the allegations of paragraph 14.

15. He admits that plaintiffs disagree with the holdings of the Patent Office with respect to the claims set out in paragraph 7 of the bill, but denies that plaintiffs are entitled to a patent containing said claims since said claims are deemed to be unpatentable over the following prior art and for the reasons given in the statement of the examiner in answer to the appeal and the decision of the Board of Appeals, copies of which will be presented at the trial:

| | | |
|---|---|---|
| Sacia | 1,623,756, | April 5, 1927, |
| Hewlett, | 1,853,812, | April 12, 1932, |
| Robinson, | 1,854,159, | April 12, 1932, |
| Hanna, | 1,888,724, | Nov. 22, 1932. |

Profert of copies of these patents is hereby made.

16. He is not informed, save by the bill itself, as to the alleged importance and value of the subject-matter
11 of the said application, but avers that the tribunals of the Patent Office have allowed a number of claims in plaintiffs' application.

WHEREFORE defendant having fully answered the bill of complaint denies that plaintiffs are entitled to the relief demanded or any part thereof and prays that the bill be dismissed with all costs of the proceedings against the plaintiffs as provided in Section 4915 R. S.

CONWAY P. COE
*Commissioner of Patents,*
*Defendant.*

R. F. WHITEHEAD
*Solicitor of the Patent Office,*
*Attorney for Defendant.*

District of Columbia, ss:

I, Conway P. Coe, Commissioner of Patents, depose and say that I have read the above answer by me subscribed and know the contents thereof, and that the statements of facts therein made as upon personal knowledge are true, and those made upon information and belief I believe to be true.

CONWAY P. COE
*Commissioner of Patents.*

Subscribed and sworn to before me this 26th day of May, 1937.

MARY K. CONNOR
(Seal) *Notary Public, D. C.*

My commission expires Oct. 15, 1940.

12 *Stipulation*

Filed March 23, 1939

* * *

It is hereby stipulated and agreed by and between counsel for the respective parties, as follows:

1. That the copy hereto attached is a correct condensation of the file wrapper and contents of application Serial No. 563,447, filed September 17, 1931 by Arnold Poulsen and Axel Carl Georg Petersen on "Reproduction Film For Reproduction of Sound and Process for Recording the Sound."
2. It is further stipulated that the above mentioned condensation of the file wrapper and contents is to be used in the transcript of record on appeal instead of the complete copy of the file wrapper and contents filed in this cause as plaintiff's Exhibit #4, the said condensation being subject to correction by and from the original file wrapper and contents should any error be found.

RALPH B. STEWART
*Attorney for Plaintiffs.*
W. W. COCHRAN
*Attorney for Defendant.*

Washington, D. C.
March 23, 1939.

13 Condensation of file wrapper and contents of application for patent, Serial No. 563,447, filed by Arnold Poulsen and Axel Carl Georg Petersen on September 17, 1931 on "Reproduction of Sound and Process for Recording the Sound".

## INDEX

| | Original | Print |
|---|---|---|
| Amended Specification .................. | 1 | 11 |
| Claims ................................ | 19 | 25 |
| Drawings .............................. | 26 | 31 |
| Examiner's Statement on Appeal......... | 28 | 33 |
| Decision of Board of Appeals on Appeal... | 42 | 43 |
| Petition for Rehearing on Appeal......... | 50 | 49 |
| Decision of Board of Appeals on Petition for Rehearing .................. .. | 52 | 50 |
| Patent No. 1,623,756,—Sacia............. | 53 | 53 |
| Patent No. 1,853,812,—Hewlett........... | 60 | 60 |
| Patent No. 1,854,159,—Robinson.......... | 65 | 65 |
| Patent No. 1,888,724,—Hanna............. | 71 | 71 |

This invention relates to new and useful methods
14 and systems for producing photographic sound records of the kind in which the sound to be recorded is first converted into an alternating current to control a sound recording device, from which a light beam is directed onto a film to form thereon a transversely disposed extremely narrow strip of light, the length or intensity of the strip of light being varied by said current about an average value in accordance with the amplitude of the individual sound waves.

Irregularities and scratches in the transparent portion of a sound film cause during the reproduction of the sounds a disturbing noise, the so-called "background noise". In order to avoid this noise it has previously been proposed to actuate the sound recording device not only by the above mentioned alternating current, i. e., a sound responsive current, but also by a direct current, which is influenced by a rectified portion of the sound responsive current so as to cause the average length or average intensity of the light strip formed on the film to vary (dependent upon the volume of the sound), whereby on the sound reproducing film prepared from the original sound record the mean transparency of the sound track decreases when the volume of the recorded sound decreases. The product is a so-called "noiseless sound record".

In order to avoid distortion in the reproduced sounds care must be taken that in the production of sound records of the variable width or of the variable density type that the variation of the average length or the average density of the said strip of light does not exceed a value which is equal to the difference between the value of the length or intensity of the light-strip during silent periods and
15 a value corresponding to 50% blackening of a transversal element of the sound track. Otherwise the length or intensity of the light strip would, when the volume of the sound is at a maximum, partly pass outside the range within which it would have to be kept for the maximum width or for the maximum degree of modulation of the exposure, respectively, of the sound track.

One object of the present invention is to insure that the variations of the average length or intensity of the strip of light formed on the film is not allowed to exceed a predetermined value. In order to attain this object, the direct current actuating the sound recording device to cause said variations is adjusted to such magnitude that it attains zero value when the volume of the sound to be recorded, or more precisely, when the magnitude of the sound responsive current reaches a predetermined arbitrary maximum value corresponding to maximum volume of the sound or some volume less than the maximum.

In a method of producing a sound record of the variable width constant density type the said direct current and the sound recording device are so adjusted that when the sound responsive current is zero or of a minimum value, the direct current maintains the sound recording device in such position that the zero line of the sound track is located near to (either inside or just outside) one edge of the sound track, whereas when the direct current is zero, the zero line of the recorded sound is displaced to a position on or near the center line of the sound track.

In methods of producing sound records of the variable density constant width type the said sound recording device is so adjusted that the intensity of the light impinging on the film is of a value corresponding to a degree of exposure of 50% or approximately 50% of the film when the direct current controlling the average intensity of
16 the light is zero.

The direct current above referred to may be the plate current of a thermionic tube. The grid bias of this tube is varied by the rectified portion of the sound responsive current.

In producing noiseless sound records the average transparency of the original, or negative, record was hitherto been caused to increase when the volume of the sound decreases in order that on a positive record copied from the negative record the transparency should decrease when the amplitude of the recorded variations decreases.

A further object of the present invention is to produce an original sound record of the variable width or of the variable density type, on which the average value of the transparency of the sound track varies inversely to the volume of the sounds to be recorded.

The original sound record produced by this modification of the invention has the advantage over known types of original records (in which silence is represented by transparency) that copies to be used for reproducing (in which

silence is represented by opacity) can be made from it by a process involving two stages only; (1) preparation by printing of a copy in which silence is represented by transparency, and (2), the printing from this copy of the actual reproducing copies. The first copy will, of course, acquire during use blemishes such as scratches, which will be represented as transparent spots or lines in the reproducing copies. However, any number of these first copies all initially equally free from blemishes, can be made from the original record, because scratches and specks of dust on this original record, which is for the most part opaque, will not appear in these copies. If in the original record silence were represented by transparency, this
17 method of making reproducing copies would involve
one extra copying operation, namely, the preparation of a "master" positive (in which silence is represented by opacity) by printing from the original record, and the opaque parts of this "master" copy would have imprinted thereon the blemishes in the transparent part of the original record. Thus, assuming the most favorable conditions in each case in the making of the reproducing copies, the present invention ensures greater freedom from blemishes giving rise to background noise than the processes hitherto proposed.

A variation of the average transparency of the sound track corresponding to an increase of the volume of the sound should appear as quickly as possible in order that the peaks of the amplitudes of the recorded variation representing the first waves of the sound of increased volume should not be cut off. This might happen because the peaks extend outside the border line of the sound track of a variable width record, and will not happen if the zero line is shifted quickly. On the other hand, when the volume of the sound decreases, the zero line should not be shifted too quickly towards the border line, because then the sound might be suddenly cut off.

It is a further object of the invention to eliminate these defects and, to this end, the variation of the average length or intensity of the strip of light formed on the film is caused to take place more rapidly than or as quickly as the corresponding variation in the volume of the sound when the sound increases, and is caused to vary more slowly than the volume of the sound when the sound decreases.

18 A sound produced suddenly after a pause, as most sounds are, will cause the occurrence of a corresponding displacement of the working point as quickly as, or more quickly than the increase of the magnitude of the sound amplitude in question, the displacement taking place away from the position occupied by the working point during the pause. Usually this last mentioned position corresponds to full blackening of the sound record track.

The sound in question will, therefore, be recorded with certainty, and when a sound dies slowly away the density will vary so slowly that it cannot reach the maximum value during the pauses before the audible oscillations to be recorded have ceased.

This adjustment of the system serving to govern a sound recording member can be attained by the mutual adjustment of the coefficients of conductivity of the circuit or of one or more of the circuits through which the rectified current is transferred to or is caused to actuate the sound-recording member, in such a manner that the variations in the rectified current are effected more quickly when the said current increases than when it decreases.

Preferably, a rectifier valve is used for rectification. The last mentioned control may be effected by inserting in the well-known manner in the anode circuit of the rectifier valve a smoothing condenser connected in parallel to an ohmic resistance. This resistance is so adjusted (depending on the ohmic resistance of the rectifier valve), that the charging of the condenser during the passage of a positive half wave through the rectifier valve will be effected more quickly than the subsequent discharge of the condenser during the occurrence of a negative half wave.

19 In order that the invention may be clearly understood and readily carried into effect, some examples of the same will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a portion of a sound film of the variable-width type produced in accordance with the present invention;

Fig. 2 shows a portion of a film having the zero line situated beyond the edge of the film;

Fig. 3 is a diagram of the connections of a system for producing the displacement on the film of the zero line of the crests and troughs of the sound record, in accordance with the present invention;

Fig. 4 is a diagram of connections of a modified form of such a system;

Fig. 5 is a diagram of connections of a third form of system adapted to displace the zero line during the recording to the sound;

Fig. 6 shows a portion of a positive film with sound record according to the transversal method and with a zero-line displacement increasing at the same rate as the amplitudes;

Fig. 7 shows a portion of a positive film on which the displacement of the zero-line of the sound record can be effected more quickly at increasing amplitudes than the variation in amplitudes, and, more slowly than the variations in the same at decreasing sound amplitudes;

Fig. 8 shows a simplified diagram of the anode circuit in a rectifier valve used in the system used in Fig. 5;

Fig. 9 shows graphically, the course of the rectified current used for governing the recording member, during the passage of a positive half wave through the anode circuit shown in Fig. 8, and the subsequent discharge of the condenser in this circuit;

Fig. 10 shows a modified construction of the anode circuit shown in Fig. 8;

Fig. 11 shows the course of the rectified current in the circuit shown in Fig. 10; and

Fig. 12 shows the wiring diagram of an amplifier stage for the rectifier constructed according to the invention.

Figure 1 shows a portion of a sound record of a known kind on which the distance between one edge *u* of the sound track and the zero line of the trace of the recorded sound waves, indicated by the dotted line *a, b,* increases as the volume of the recorded sound increases. When the volume of the sound to be registered is at a maximum, the distance between the edge *u* of the sound track and the zero line *a, b,* is equal to half the width of the sound track, so that the zero line coincides with the center line of the sound track, when the volume of the recorded sound is at a maximum.

The distance between the edge *u* of the sound track and the zero line *a, b,* is varied during the recording by displacement of the zero line transversely in relation to the record. This displacement is caused by means of a unidirectional current which is modified by a rectified portion of the sound-responsive current and actuates the recording means, so as to alter the mean position about which the said means vibrates due to the sound-responsive current. This will be more fully understood from the description set forth below in connection with Figs. 3 to 5.

In the known method of producing sound records, the unidirectional or biasing current increases as the volume of the sound increases. Under certain circumstances this may cause the transverse displacement of the zero line from a position near the edge of the sound track to exceed
half of the width of the sound track, viz. if the vol-
21 ume of the sound exceeds a predetermined maxi-
mum value. This causes distortion of the sounds reproduced from the record, because the peaks or the troughs of the sound wave are not recorded when the distance between the zero line *a, b* and the edge *u* of the sound track is greater than half the width of the sound track. This happens if the zero line *a, b* during its displacement passes beyond the center line of the track. In order to avoid this, we control the displacement of the zero line *a, b* by a unidirectional current which is reduced as the volume of the sound increases, so as to attain zero-value when the volume of the sound is at a maximum. The recording means is adjusted to such a position relatively to the record that when the unidirectional current is zero, the zero line *a, b* of the recorded waves coincides with the center line of the sound track. When the volume of the sound decreases the unidirectional current is increased and causes the zero line *a, b* to move toward an initial position. This is the position occupied by the zero line when no sounds are to be recorded, and it either coincides with the edge *u* of the sound track, or is located either slightly inside the edge *u* of the sound track, as at *c, d* in Fig. 1, or preferably slightly outside the edge *u* as indicated by the line *c, d* in Fig. 2.

The records shown in Figs. 1 and 2 are supposed to be records suitable for use in the sound reproducing apparatus and the cross-hatched areas of the records represent the exposed or opaque portions of same. These records are produced by a double copying process from a corresponding original negative record.

22 Fig. 3 shows a system for varying the position of the zero line of a sound-recording apparatus in the manner described above.

The current into which the sounds are converted is passed through an amplifier *e* and a transformer *f* to the sound-recording apparatus *g*, which, in the construction shown, is assumed to be an oscillograph with a wire loop *h* carrying a mirror *i*. The primary winding of a transformer *k* is connected in parallel with the primary winding of the transformer *f* and the secondary winding of the transformer *k* is included in the grid circuit of a thermionic valve *l* in which the secondary current of the transformer *k* is rectified. The rectified current serves to actuate a polarized electromagnetic relay *m*, athough an electrodynamic relay may obviously be used instead. *n* is a variable resistance consisting of a liquid in a tube of narrow cross-section and varied by the relay *m* in such a manner that the ohmic resistance between the terminals of the tube is increased with the increase in the said rectified current. The resistance *n* and a battery *o* in series with it are connected in parallel with the secondary winding of the transformer *f*. The battery *o* will thus deliver a current passing through the resistance *n* and the wire loop *h* of the oscillograph.

The mechanical inertia of the relay *m* will be, as a rule, sufficient to smooth out the pulsations of the rectified current, but these pulsations may also be removed by other means, for example, by a filter. The current passing through the resistance *n* so actuates the oscillating system, consisting of the mirror *i* and the loop of the oscillograph as to alter the zero position of the latter. The alternating current passing through the transformer *f* to the wire loop thus causes the said system to oscillate
23 about a zero line, the position of which depends on the current passing at any time through the battery *o*, the resistance *n* and the loop *h*.

The adjustment of this device is effected in the following manner:

The moving system *h* of the oscillograph is mechanically set so that the zero line of the sound trace lies along the center line of the sound track, the circuit of battery *o* having been interrupted. Then the transformer *k* is disconnected and an alternating current is passed through the amplifier *e* at such a constant amplitude as to be equivalent to the maximum amplitude of the currents representing the sounds to be recorded. The circuit is then adjusted so that the trace on the record representing the steady alternating current is of the full width of the sound track. The transformer *f* is next disconnected and the transformer *k* connected. The voltage of the battery *o* is then adjusted without any current flowing in the amplifier *e* so that the moving system *h* of the oscillograph is deflected until the extreme end of the line of light on the film takes up the position of extreme peaks of the waves caused by the alternating current of constant amplitude through the transformer *f* mentioned above. Finally, with no current flowing through the oscillograph loop *h*, the zero position, corresponding to the center line of the sound track is again checked, or if necessary readjusted mechanically. The electrical resistance of the oscillograph loop *h* is in practice very small in comparison with the resistance of the liquid in the tube *n* so that proportionality is obtained between the direct and alternating currents passing through the loop.

During periods of silence the only factor operating is the battery *o* and the end of the line of light will be shifted to a point at or near the edge of the sound track as
24 shown at *c, d* in Fig. 1, or just outside the sound track as shown in Fig. 2. Sound oscillations cause oscillations of the loop *h* depending upon their amplitude. The rectified current, also depending upon the amplitude of the oscillations, passes through the instrument *m* and increases the resistance *n* and decreases the current from the battery *o* in proportion to the amplitude of the sound waves. When the latter are of maximum value the resistance is so great that substantially no current flows from the battery *o* and the zero line *a, b* of the sound trace is at the center line of the sound track.

Instead of an oscillograph with an oscillating mirror any other suitable recording apparatus may be used for recording, provided that the neutral position can be varied by the action of a direct current. For example a glow-lamp oscillograph may be used in which the length of the luminous portion of the discharge is regulated by the alternating currents corresponding to the sounds and also by a direct current voltage which is controlled in the same manner as the above-mentioned direct current.

In the arrangement shown in Fig. 4, the relay *m* is replaced by a thermionic valve *p*, the anode circuit of which includes the wire loop *h* of the oscillograph and two resistances *q*, arranged in series, and placed one on each side of the wire loop. The wire loop and the resistances are shunted by a condenser *r*. The object of this arrangement is to prevent currents of acoustic frequencies in the anode circuit from affecting the oscillating system of the oscillograph.

The output circuit of the amplifier *e* contains a potentiometer resistance *s* and a rectifier *t* of suitable type, and the variable portion of the resistance *s* is connected between the grid and cathode of the valve *p*. The anode current of the valve *p* is the unidirectional current, referred to above. As in Fig. 3, a portion of the sound-responsive current in the output circuit of the amplifier *e* is rectified by the rectifier *t*, and the rectified current flows through the resistance *s* and produces variations of the grid bias of the valve *p* in accordance with the effective value of the rectified current and, consequently, in accordance with the volume of the sound. The variations of the grid potential of the valve *p* cause corresponding variations of the anode current of the valve, whereby the above-mentioned variations are produced in the position about which the loop and the mirror *i* are caused to vibrate by the action of the sound-responsive current in the secondary winding of the transformer *f*.

The adjustment of this device is effected in the following manner:

As in connection with Fig. 3, the end of the line of light is set to the middle of the sound track by mechanical setting of the moving system *h* of the oscillograph with no current flowing in the system. Then the rectifier *t* is disconnected as before, and an alternating current of constant amplitude corresponding to the maximum amplitude of sound to be recorded is applied to the amplifier *e* and the circuit adjusted so that the end of the line of light rests on the line *c*, *d* as shown in Fig. 1 or Fig. 2. The alternating current is then switches off from the amplifier *e* and the bias battery of the valve *p* adjusted so that its grid bias

potential allows a direct current to pass from the battery *o* through the anode circuit of the valve *p* and through the oscillograph loop *h* with just sufficient magnitude to bring the end of the line of light again to the line *c, d* in Fig. 1 or Fig. 2. Then, without reconnecting the transformer *f,* the rectifier *t* is again brought into circuit and alternating current of the same constant amplitude as before is ap-
26 plied to the amplifier *e.* The resistance *s* is then adjusted in order to vary the amplification due to the valve *p* until, with the alternating current mentioned flowing in the amplifier *e,* the current from the battery *o* is reduced to zero. This is indicated by the fact that the oscillograph moves the end of the line of light on the film back to the center line of the sound track. The moving system of the oscillograph may be reset again with no current flowing until the zero line occupies the center of the sound track. It will be evident that, if the system is adjusted in the manner described above, the zero line of the recorded waves would never be displaced further than up to the center line.

The system shown in Fig. 5 differs from the form shown in Fig. 4 mainly in that the rectifier *t* is replaced by a transformer *k* and a rectifying valve *l.* The primary winding of the transformer *k* is connected across the output circuit of the amplifier *e* and the secondary winding of the transformer *k* is connected between the grid and the cathode of the valve *l.* The valve *l* rectifies the current in the secondary circuit of the transformer *k,* and the rectified current is smoothed by a filter A in the plate circuit of the said valve. This circuit includes, in addition, the resistance or potentiometer *s* which is connected between the grid and the cathode of the valve *p.* The rectified and smoothed current in the anode circuit A of the tube *l* produces voltage variations in the resistance *s* and thus reduces the negative grid-bias potential as it itself increases. When the resulting grid-bias potential reaches a value at which the anode current of the valve *p* becomes zero, and the zero line is consequently moved to the center line of the sound track then, a further increase of the said voltage variations, that is to say, a still more powerful impulse through the transformer *k,* will cause no further alteration of the anode current and, consequently, no further dis-

placement of the zero line. As a result, the zero line
27 cannot be displaced during recording beyond the center line of the film.

It will be noted that the valve *p*, shown in Figs. 4 and 5, constitutes a separate amplifier or modulating device for the unidirectional current and is separate from any part of the amplifier *e* used for amplifying the sound-responsive current which flows through the oscillograph loop *h*.

In the above, the recording apparatus is assumed to be an oscillograph; it is, however, within the scope of the invention to use any other sound recording apparatus adapted for recording sounds and sound oscillations according to the variable-width method.

In practice, good results have been obtained with the circuit shown in Fig. 4 where the resistance of the rectifier *t* was 10,000 ohms, the resistance of S 200,000 ohms, and the capacitance of the condenser bridged across S, 0.1 microfarad.

With the circuit shown in Fig. 5, good results were obtained with the constants chosen as follows: The resistances of the first two resistances connected with the plate of the rectifier each 100,000 ohms, and of the third resistance in series therewith 150,000 ohms, the resistance of S 200,000 ohms, and the capacitance of the condensers bridged across the output circuit, of the rectifier 0.15 microfarads of the condenser immediately following the rectifier *l*, and 0.1 microfarads of each of the other two condensers.

While it is rather complicated to calculate the time constants of the circuit on the rise and on the fall of the rectified current, we have measured the time it takes for the bias current to fall to zero at increasing sound volume and the time it takes to reach its normal value at decreasing
sound volume. We have found that it takes 5 milli-
28 seconds for the bias current to fall to zero and 40
milliseconds for the bias current to increase to normal value. These values were found, in the first case by suddenly applying an a. c. to the microphone amplifier of an intensity corresponding to a full amplitude on the film and, in the second case by suddenly interrupting the a. c. In practice the sound does not start with full amplitude and 5 milliseconds will be a sufficiently short time to avoid imperfect recording.

Figure 6 shows a portion of a film on which the sound record is made according to the transversal method, the zero-line *a, b* being displaced inward from the edge of the film towards the centre thereof, in such a manner that the speed at which this displacement is effected is essentially the same as the one at which the variations in the sound amplitudes are effected, being for instance proportional to the last mentioned speed.

In Figure 7 a portion of a film is shown on which the zero-line, at the commencement of the sound, is displaced faster than the amplitude of oscillation is increasing, cf, the left-hand side of the sound record in Figure 7, and at the cessation or decrease of the sound record is moved back more slowly than the decrease of the amplitude of oscillation, cf. the right-hand side of the sound record in Figure 7.

The zero-line a-b may be considered a graphical representation of the curve-shape of the rectified current in the system shown in Figure 5, as it will practically be of the same shape as the said curve. The curve-shape of the rectified current will depend on the constants in the anode circuit of the valve l. A diagram of this circuit is shown in Figure 8, where the valve l, which is to be considered a source of current with a certain internal resistance, is replaced by an alternating current source Q and a resistance R, which represents the internal resistance of the valve l.

During the positive half wave of the alternating
29 current the resistance R will have another mean
value than during the negative half wave, as it will practically be infinitely great during the occurrence of the last mentioned half wave. Therefore the condenser K will be charged through the resistance R during the occurrence of the positive half wave, and discharged through the resistance s during the occurrence of the negative half wave.

Assuming for the sake of simplicity that the anode circuit is only actuated by one single oscillation, the variation of the voltage across the resistance s will be represented by the curve E in Figure 9. Disregarding the influence of the resistance s on the time constant for the anode circuit during the charging of the condenser K, which may be done with great approximation provided that the resistance s is proportionally as great as the resistance R and the capacity of the condenser K, the time constant for the anode circuit will be expressed by the product R . K during the charging and by the product K . s during the discharge, which latter is effected solely across the resistance s. It will be seen that by variation of the values of the resistance s and the condenser K relatively to the internal resistance R of the valve 1, the curve-shape for the rectified current $i_r$, Figure 9, can be modified in such a manner that it will assume the shape or approximately the shape indicated by the zero-line a-b in Figure 7, cf. the full-line curve for the current $i_r$, Figure 9.

If the frequency of the alternating current is high, viz. so high that the duration of the period is short in comparison to the time of charging and discharging for the condenser K, the rectified current will be practically completely equalized. If, on the other hand, the frequencies of the alternating current are low, and the duration of the alternating-current period is of the same order of magnitude as the charging and discharging times for the condenser K, difficulties will be created in equalizing by means of the resistance s. If the equalization is imperfect the rectified current will have an alternating-current component, which not only may cause an amplification or a weakening of the frequency concerned, but also may introduce higher harmonics. If we attempt to remedy this drawback by making the time constant K . s very great, or by inserting several filters in series, the difficulty will be created that the time of discharge of the condenser K, after the oscillations have ceased entirely, will be very long, the consequence being that the zero-line will not return to its initial position until a long time after the sound has ceased, or will not return to its initial position at all until the next sound has commenced. The sound pauses will therefore not be noiseless.

The last mentioned drawback may suitably be remedied by the insertion of a self-induction P in series with the resistance s, as shown in Fig. 10. The self-induction will then flatten the first part of the discharge curve of the condenser K, as shown in Fig. 11, that is to say the filter effect will be improved, without increasing the time of discharge.

Figure 12 shows the circuit diagram for a rectifier valve where the self-induction P is inserted in the grid circuit of the rectifier in series with the leak resistance H. The resistance s and the condenser K are inserted in the anode circuit of the rectifier valve. The time constant for the entire rectifier arrangement according to Figure 12 is greater than the time constant for the rectifier according to Fig. 10, provided that the time constant for the
31 anode circuit, i. e. the product K . s be not a small
quantity.

In the above an electron valve is supposed to be used for the rectification, but any other type of rectifiers may of course be used, and instead of a mirror any other oscillating sound-recording member may be used, perhaps a vacuum tube on which the rectified current is caused to act in such a manner that the extent of the light or the intensity thereof, in a manner known per se, is varied in accordance with the said current.

In recording sounds in the manner described above a beam of light from a light source L, Figure 3, is in the usual manner concentrated on the mirror i by way of a lens C to form a linear image L′ disposed transversely to the axis of vibration of the mirror. The light source L should preferably be linear. If a light source which is not linear is used, a screen provided with a slit is inserted between the light source and the mirror and a linear image of the said slit is then formed on the mirror by means of lens C.

The light rays reflected from the mirror are concentrated on the film F by means of a cylindrical lens B to form a linear light strip L″ on the surface of the film disposed transversely by direction of movement of the film, which movement is indicated by the arrow in Figure 3. The vibrations of the mirror are transferred to the beam of light reflected from the mirror and thereby the recording is performed in a manner known per se.

For the sake of simplicity the optical system for concentrating the light on the film is not shown in Figs. 4 and 5, but a recording device similar to that described in connection with Figure 6 is to be used.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

49. An apparatus for producing a photographic
32 sound record of the variable-width type comprising
means for directing a beam of light on to a moving film so as to form a transversely disposed narrow strip of light on the film, means actuated by a sound responsive current for varying the length of the strip of light in accordance with the amplitude of the sound, a thermionic tube arranged so that its plate current actuates light varying means, means for applying a biasing potential to the grid of said tube, means actuated by a rectified portion of the sound responsive current for controlling said biasing potential in accordance with the volume of the sound so as to cause the plate current of the tube to vary in accordance with the volume of the sound, the apparatus being so adjusted that the zero line of the sound trace takes up such an initial position relatively to the sound track that, when the plate current attains a zero value, the zero line moves from the said initial position into the center line of the sound track, said apparatus including an oscillograph for directing the beam of light on to the film and for swinging the beam in accordance with the amplitude of the sound, in which the loop of the moving system of the oscillograph is connected in the plate circuit of the thermionic tube in series with two ohmic or inductive resistances, which are arranged one on each side of the loop, with a condenser connected across the said resistances and the loop, in order to prevent current of audible frequencies in the plate circuit from affecting the mean position of the moving system of the oscillograph.

54. A system for recording sound photographically on a moving light-sensitive film by directing a beam of light onto the film, varying the average exposure of the film in accordance with the volume of the sounds by rectifying a portion of the microphone currents into which the sound waves are converted for recording purposes, caus-
33 ing the rectified current to control the actuation of
the sound recording member so as to vary the mean position about which the beam of light concentrated on the film is oscillated by the action of the microphone currents at a rate which increases for increasing volume of the sound, in which the electric circuit through which the rectified current flows after amplification to act upon the

sound recording member, are of such value that the variation of the rectified current at increasing volumes of sound is effected more rapidly than the variation of the volume of the sound, and at decreasing volumes is effected more slowly than the variation of the volume of the sound.

56. A system for recording sounds on a light-sensitive film comprising means for converting the sounds into a varying electrical current, a light source, a mirror oscillated by said current and reflecting a bundle of rays from said light source towards the film, means to concentrate said rays on the surface of the film to form a transversely disposed linear strip of light on same, a rectifier for rectifying a portion of said current, a thermionic amplifier, a wire loop carrying said mirror and inserted in the plate circuit of said amplifier and a resistance inserted in the circuit of the rectified current and connected across the grid circuit of the thermionic amplifier in order that the grid-bias should vary in accordance to the magnitude of the rectified current for the purpose of causing corresponding variations of the plate current of the amplifier, whereby the mean position about which the mirror is oscillated by the influence of the varying current into which the sounds are converted, is altered in dependency of the magnitude of the sound amplitudes so as to cause the zero-line of the recorded sound to be displaced transversely to the film from an initial position at one edge of the film towards the middle of the same at a rate increasing for increasing amplitudes of the recorded sounds, the conductivity of the last mentioned circuit being adjusted so as to cause that the variations of the rectified current, corresponding to increasing sound amplitudes, to be effected more quickly,
and the variation of the same current corresponding
34 to decreasing amplitudes to be effected more slowly
than the variations in the sound amplitudes.

58. A system for recording sounds on a light-sensitive film, comprising means for converting the sounds into a varying electrical current, a light source, means to concentrate a bundle of rays from said light source on the surface of film to form thereon a transversely disposed linear strip of light, means to cause said strip of light to oscillate transversely to the film by the influence of said current, a rectifying valve having a primary circuit connected across

a circuit of said varying current and a secondary circuit, a condenser inserted in said secondary circuit, an ohmic resistance connected across the said condenser and adjusted to such value depending on the ohmic resistance of the rectifying valve that the charging of the condenser during the passage of a positive half wave through the rectifier is effected more quickly than the subsequent discharge of the condenser, a thermionic amplifier having a grid circuit including said resistance and a plate circuit including means by which the plate current of the amplifier controlled by the grid-bias of the amplifier and consequently by the charge and discharge of said condenser is caused to shift the mean position about which the strip of light is oscillated more quickly transversely to the film when the amplitudes of the sound increase than when the amplitudes of the sound decrease.

59. A system as defined in claim 58, in which an inductance is connected in series with the ohmic resistance connected across the condenser in the secondary circuit of the rectifier.

65. A system for recording sounds on a light sensitive film comprising means for converting the sounds into a varying electrical current, a light source, means to concentrate a bundle of rays from said light source onto the surface of the film to form thereon a transversely disposed linear strip of light, means to cause said bundle of rays to vary so as to cause the exposure of the film to vary in accordance with the volume of the sound, a rectifier rectifying a portion of said varying electrical current, and a circuit through which the said rectified current influences the sound recording means to cause the said bundle of rays to oscillate dependent on the volume of the sound to be recorded, the electrical constants of at least one of the circuits through which the rectified current acts upon the sound recording member being of such a value that the rate of decrease of the current acting upon the recording means is greater during increase of the sound intensity than the rate of increase of the peak value of the alternating current.

66. A system in accordance with claim 65 in which the conductivity of one of the circuits through which the rectified current is caused to act upon the recording device

is so adjusted that the variations of the rectified current corresponding to increasing sound amplitudes are effected more quickly, and the variation of the same current corresponding to decreasing amplitude are effected more slowly than the variations in the sound amplitudes.

67. A system according to claim 65 in which said rectifier is a valve by which a portion of the sound-responsive current is rectified, said valve having a plate circuit including an ohmic resistance and a smoothing condenser connected across said resistance, and an inductance connected in series with said resistance in order to flatten out the first portion of the discharged characteristic of the said condenser.

68. A system for recording sounds on a light sensitive film, comprising means for converting sounds into an alternating current, a light source, means to concentrate a beam of light from said light source onto the surface of the film so as to form thereon a transversely disposed linear
36 strip of light, means to cause the exposure of the
film to vary in accordance with the alternating current, a rectifier rectifying a portion of said alternating current, and a smoothing circuit through which the rectified current influences said sound recording means to cause the said exposure to vary dependent on the volume of sound, the electrical constants of the rectifier and said smoothing circuit being so adjusted that the rate of increase of the rectified current during increase of the sound intensity is greater than the rate of increase of the peak value of the alternating current.

69. A system for recording sounds on a light sensitive film comprising means for converting sounds into an alternating current, a light source, means to concentrate a beam of light from said light source onto the surface of the film so as to form thereon a transversely disposed linear strip of light, means to cause the exposure of the film to vary in accordance with the alternating current, a rectifier rectifying a portion of said alternating current, and a smoothing circuit through which the rectified current influences said sound recording means to cause the exposure to vary dependent on the volume of sound, the electrical constants of the rectifier and said smoothing circuit being so adjusted that the rate of decrease of the rectified current

during decrease of the sound intensity is less than the rate of decrease of the peak value of the alternating current.

70. A system for recording sounds on a light sensitive film comprising means for converting sounds into an alternating current, a light source, means to concentrate a beam of light from said light source onto the surface of the film so as to form thereon a transversely disposed linear strip of light, means to cause the exposure of the film to vary in accordance with the alternating current, a rectifier rectifying a portion of said alternating current, and a smoothing circuit through which the rectified current influences said sound recording means to cause the exposure to
37 vary dependent on the volume of sound, the electrical constants of the rectifier and the smoothing circuit being so adjusted that the time constant of the total rectifying circuit is of smaller value when the rectifier is operative than when it is inoperative.

71. A system for recording sounds on a light sensitive film comprising means for converting sounds into an alternating current, a light source, means to concentrate a beam of light from said light source onto the surface of the film so as to form thereon a transversely disposed linear strip of light, means to cause the exposure of the film to vary in accordance with the alternating current, a rectifier rectifying a portion of said alternating current and a smoothing circuit through which the rectified current influences said sound recording means to cause the exposure to vary dependent on the volume of sound, and means for regulating the rate of rise of said rectified current independently of the rate of fall of said current.

72. The method of producing a photographic sound record comprising the following steps: directing a light beam onto a moving film so that it receive a transversely disposed extremely narrow strip of light, variably exposing the film in accordance with the amplitude of each individual sound wave, controlling the light impinging on the film to vary the average exposure of the film as the volume of the sound to be recorded varies, and holding the variations of the average exposure between predetermined lower and upper limits.

73. The method according to claim 72 and in which the lower limit of the average exposure variation is approximately zero.

74. The method according to claim 72 and in which the upper limit of the average exposure variation is substantially midway between zero and full exposure.

38 75. The method according to claim 72 and in which the average exposure of the film is varied more rapidly than the amplitude of the sound varies when the sound volume increases, and more slowly than said amplitude varies when it decreases.

76. In a photographic sound recording system including a moving film, a source of light and a light flux controlling element, sound modulated alternating current means for controlling said element to expose the film in accordance with the amplitude of each individual sound wave, and biasing means for controlling said element to vary the average exposure of the film between a predetermined lower and a predetermined upper limit.

77. The recording system according to claim 76 and in which the lower limit is approximately zero.

78. The recording system according to claim 76 and in which the upper limit is substantially midway between zero and full exposure.

79. The recording system according to claim 76 and in which a source of unidirectional current applies a constant bias on said element, and means for applying a rectified portion of the alternating current to reduce the bias substantially to zero as the sound volume increases from zero to a predetermined maximum.

563447 ~~DIV.~~ 5

2 SHEETS-SHEET. 1

Fig. 1.

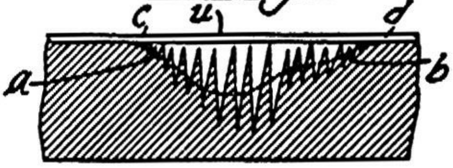
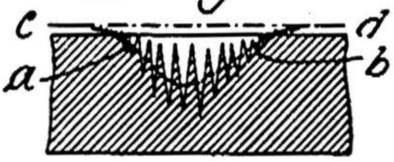


Fig. 2.



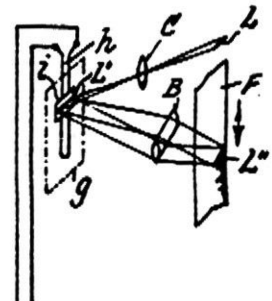


Fig. 3.

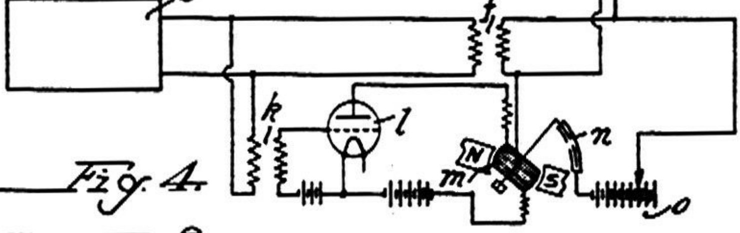


Fig. 4.

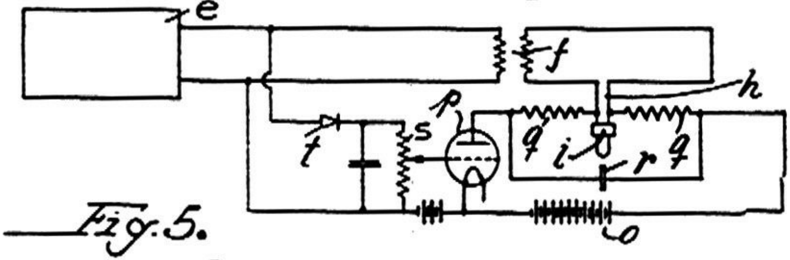
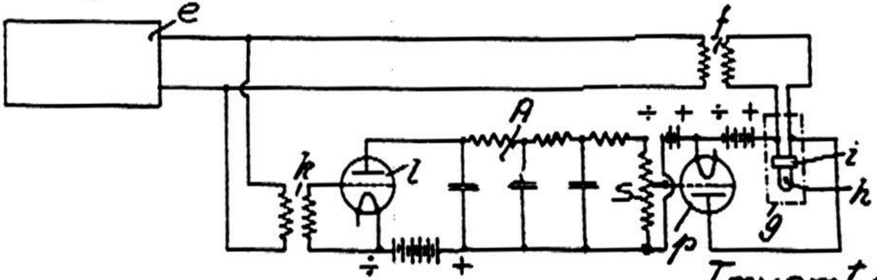


Fig. 5.



Inventors:
Arnold Poulsen and
Axel Carl Georg Petersen
By Emil Bonnelycke Attorney

1 2

Fig. 6.

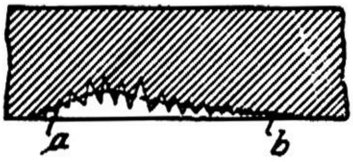


Fig. 7.

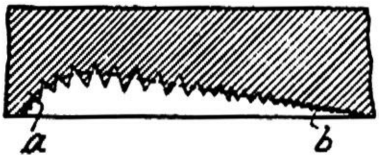


Fig. 8.

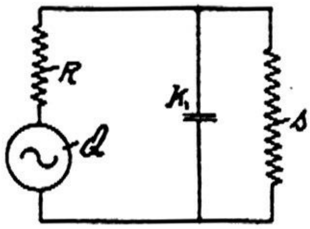


Fig. 9.

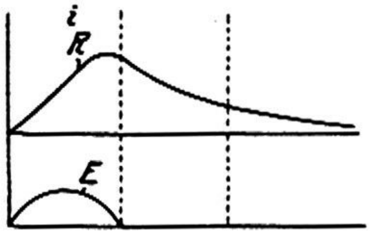


Fig. 10.

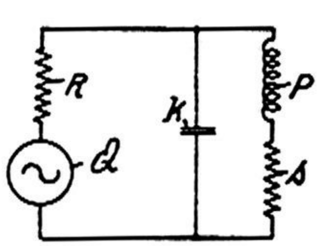


Fig. 11.

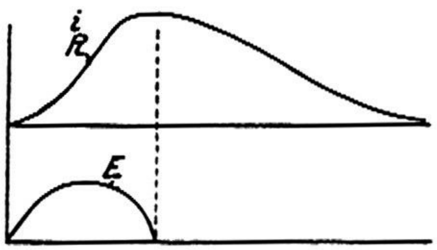
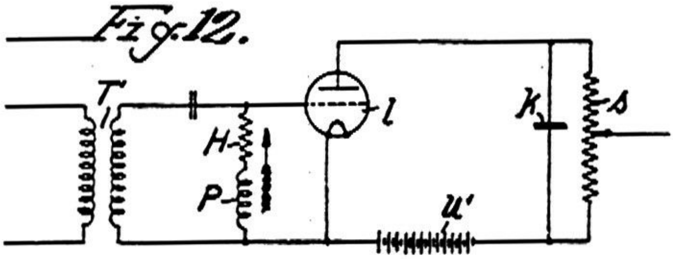


Fig. 12.



Inventors:
Arnold Poulsen and
Axel Carl Georg Petersen
By Emil Bonnelycke
Attorney

## 41 Examiner's Statement on Appeal before the Board of Appeals.

July 16, 1936

Applicant appeals from the final rejection of claims 56, 65 to 67, 70 and 72 to 79. Claims 54, 58, 59, 68, 69 and 71 are found to be allowable. The above mentioned claims constitute all of the claims now remaining in this application, except allowed claim 49 upon which a recommendation is made that it be rejected.

(Here follows claims 49, 56, 65 to 67, 70 and 72 to 79, but since these claims appear at the end of the specification they are not reproduced here).

The references relied upon are as follows:

| | | | |
|---|---|---|---|
| Sacia | 1,623,756 | April 5, 1927 | 179-100.3 |
| Hanna | 1,888,724 | November 22, 1932 | 179-100.3 |
| Robinson | 1,854,159 | April 12, 1932 | 179-100.3 |
| Hewlett | 1,853,812 | April 12, 1932 | 179-100.3 |

The subject matter of this application concerns the modification of a standard sound on film recorder, in order to eliminate or materially reduce the ground noise inherent in the film, which on reproduction of the record is objectionable in silent periods and when the intensity of the sound is low. The following discussion of the prior art will make clear what has already been accomplished in this field.

The standard sound recorder consists essentially of a microphone 3, amplifier 4, light modulator 5 and light sensitive film 7 as shown in figure 1 of the Sacia patent.

Two types of records may be made. A variable density record in which the light modulator causes a constant area projected on the film to vary in light intensity linearly with the sound intensity and frequency. A variable area record in which the light modulator causes a constant

42 intensity light projected on the film to vary in area linearly with the sound intensity and frequency.

The ear has its limits or range of frequency and intensity; likewise any recorder has its limits or range which if equal to that of the ear would be a perfect recorder. Sacia recognized the desirability of a wider range for a recorder which at that time was very limited, and solved the problem of extending the lower and upper limits of the range of a standard variable density recorder.

He accomplished this by taking some of the speech current, rectifying and passing it through a low pass filter. The resulting current was found to be proportional to the amplitude variations of the sound. Using some of this as a control current on the grid of a regulating amplifier, the low intensities were increased to approximately one half the intensity range and the high intensities were reduced to approximately one half the intensity range. The result was a constant intensity record of the frequency variations of the sound.

Since the inherent ground noise of the film is only objectionable at zero and low intensities, this constant intensity record made at approximately half intensity of the original sound eliminates the objectionable features of the inherent ground noise of the film.

A control record is made of part of the control current and used in the reproducing apparatus to restore the original range of intensity variations of the sound, using a record made at approximately one half the original intensity range. As pointed out the ground noise of the film is eliminated and the lower limits of the range of the sound
43 increased, because said lower limit now can be used
as there is no objectional ground noise therein. Obviously, the upper range is increased by approximately one half.

Sacia particularly points out, page 3, lines 4 and 5 that the two records may be separate or on the same record track. And in lines 10 to 20, "It may be necessary to cause operation of the circuit used for making the (a) record to lag slightly behind the operation of the circuit for making the (b) record to insure due action of the amplification regulator. This time lag may be obtained by the use of an electrical network—." It is clear that Sacia recognized that the successful operation of his device depended upon the proper time action of his control circuit and that he provides an electrical network means for insuring such proper time action.

Hanna's contribution to the art consists of the adaptation of the Sacia principle to a particular recorder for making the two records on a variable area type single sound track. Hanna found that by partly compressing the intensity range as distinguished from the constant completely compressed intensity sound record of Sacia, he could make the control record on the speech record by biasing the oscillograph with the control current that Sacia used to make his separate control record.

It is to be noted that in the variable area records of Hanna lines 12 to 23 refer incorrectly to the positive and negative records figure 2 is the negative and figure 1 the positive used in the reproducing device as will be obvious from this discussion. The chief noticable difference between this record and the record produced by standard variable area apparatus is that the transmission is kept below 50% which transmission corresponds to 100% modulation or maximum intensity of the recorded sound.

Since the inherent ground noise of the film is a
44 *minimum* at *maximum intensity* and a *maximum* at
*minimum intensity,* it is clear that the inherent ground noise of the film is proportional to the amount of clear area of the film, which is always approximately 50% in the standard variable area film.

About this time in the development of the art the amplifiers were perfected to a point where special means to increase the upper limit of the intensity range were not needed. The Robinson patent discloses a particular circuit and describes the adjustments necessary to the operation for recording, either a variable area or variable density sound record in which the lower limit of the intensity range has been extended by the elimination of the ground noise inherent in the film. The adjustment of a ground noise elimination recorder is important, because the value of the result obtained is largely determined thereby. Such adjustment is particularly pointed out on page 2, lines 99 to 121 of the Robinson patent.

All oscillograph elements have an adjustment for positioning the mirror. In a standard variable area sound recorder the mirror is adjusted so that the recording edge of the line of light projected on the film lies in the center of the sound track. This must necessarily be so, in order that the maximum swing of the beam just reaches both edges of the space to be occupied by the record. A constant frequency sound (or current) is passed through the

recorder representing maximum sound intensity and the controls set so that the swing of the beam almost touches each edge of the track area. This adjustment represents maximum intensity of the sound or 100% modulation. If it did not, the higher intensities would swing the beam off the track and result in distorted sound. Obviously, any intensity less than maximum falls within the track area, and the boundary between the edge of the track and
45 the envelope of the recorded waves represents unused
clear area of the sound track. The imperfections vary the uninterrupted passage of light through this clear area causing the ground noise inherent in the film. Obviously, this unused clear area is a maximum at zero intensity and zero at maximum intensity. Consequently, sound of very low intensity, in which the ground noise is comparable in intensity with the reproduced sound and objectionable for that reason, was at first put up with, then reduced by amplification control and now eliminated by the devices here discussed from the reproduced sound.

In the standard variable area recorder modified for ground noise elimination, the speech current is set for maximum intensity or 100% modulation, as pointed out above, so that the complete track area is used for maximum sound intensity. With the same adjustment of the oscillograph wherein the zero line lies in the center of the sound track, the rectifier current to bias the mirror may be connected in various ways as shown by the Hanna, Robinson and Hewlett patents.

The zero line will swing as a result of this current toward the recording edge of the beam; or if the connections of polarity thereof are reversed it will swing away from the recording edge of the beam. Obviously, the bias may be set at any value desired between zero and a value that will move the recording beam a distance equal to one half of the track width at maximum intensity or 100% modulation, depending of course upon the amount of ground noise reduction desired. Since the bias from the rectifier and low pass filter increases as the sound intensity, a battery, or equivalent device (such as 35-39 of Hanna) must be inserted and connected in opposition in the output circuit of the rectifier to give a bias which varies
46 *inversely* as the *sound* intensity, so that at *minimum*

or zero sound intensity the bias is a maximum, and at *maximum sound intensity* the bias is minimum or zero.

With the value of the bias set so that the beam is moved a distance equal to one half the track width at maximum sound intensity, a positive or a negative sound record is recorded, depending upon the polarity of the bias connection, such positive and negative records are shown in figures 1 and 2 of Hanna. Note that in the positive of figure 1 all of the unused clear area, and with it the inherent ground noise, is eliminated.

The inversely varying biasing means 35 of Hanna may be eliminated by changing the zero line from the center of the sound track to one edge with the mirror adjustment of the oscillograph. Here the directly varying sound intesntiy bias is required to move the zero into the center of the track for maximum sound intensity. Obviously the polarity of the bias connection must be such that the device is operative for whatever recording edge of the light beam is selected by the oscillograph adjustment; that is, the bias must move the zero line toward the recording edge when the right hand side of the track is selected for the oscillograph adjustment. In this position a negative record would be made. If the left edge of the track were selected by the oscillograph adjustment, the polarity of the bias would be such that the zero line would be moved away from the recording edge and a positive record would be made.

The Hanna patent is illustrative of the inversely varying bias and the Robinson patent is illustrative of the directly varying bias.

The Hewlett patent discloses a biasing network capable of being inserted at any convenient place in a single lead of
the speech circuit as distinguished from the branch
47 circuit of Sacia, Hanna and Robinson. He also
states page 3, lines 19 to 30. "The interval of time required for the mean plate current to assume its proper value is determined by the condenser 31 and grid leak resistance 32 and also partly by resistance 36 and condenser 37. As shown in figure 2 with apparatus having resistance and capacity values such as those mentioned, *a few cycles are required for the signal to reach its full amplitude.* This however does not materially affect the sound of the record when reproduced". Hewlett adds to the disclosure of the

delay network of Sacia, a network having resistors of 22,500 and 100,000 ohms, and capacitances of 2 m. f. and o.1 m. f. Applicants invention must define over this delay network disclosure. The subject matter of this alleged invention discloses a variable area ground noise eliminating sound recorder with a particularly designed delay circuit to insure proper time operation of the control circuit.

In view of the fact that applicant is relying upon an effective filing date in Germany of September 26, 1930 and the office required to cite references filed prior to that date; and that approximately two-thirds of the specification has been rewritten and much amended; it is believed proper to subject the *disclosure* as *filed* to an analysis in view of the prior art in order to determine if all or what part thereof conforms to the requirements of R. S. Sec. 4888, which is the consideration given by applicant for the grant of a monopoly and upon which the claims defining the scope of the monopoly must be based and interpreted to be valid.

Paragraphs 1 to 5 of the original disclosure allegedly set out the prior art in Germany, and the disadvantages there enumerated can not be found in the Sacia patent
48 bearing the earliest filing date of the prior art cited in this application. The loss of light on the photocell due to blackening out the unused clear area that causes the ground noise is an inherent or unavoidable disadvantage of all ground noise eliminating recorders including this disclosure, and since in this country the maximum light intensity available is used in standard recorders as well as recorders of this type, this inherent disadvantage must be and is compensated for by additional amplification to that used in a standard recorder.

Paragraph 6 sets out the object of this invention which is directly readable on the Hanna, Robinson and Hewlett patents.

Paragraph 7, 8, 9, 10, 11 to line 18, and 12 describe functionally the disclosure of the Hanna, Robinson and Hewlett patents, and mention the possibility of replacing the microphone of a ground noise elimination recorder with the output circuit of a standard recorder and changing a standard sound record into an anti-ground noise record. This is believed to be an obvious procedure.

Paragraph 11 lines 18 to 25, 13 and 14 to 16 describe functionally a particular means or delay network for governing the time action of the control circuit, so that the action of the control is made in a shorter period of time than the disengagement of the control in order that certain parts of the recorded sound wave may be undistorted. This particular means and its function can not be found in the Hanna, Robinson and Hewlett disclosures.

Paragraph 17 briefly describes the figures of the drawing.

Paragraph 18 to 26 describe the alleged results produced
by the ground noise elimination recorder of this in-
49 vention, illustrated in figures 1 to 5, which the ex-
aminer believes to be the same as the results produced by the Hanna, Robinson and Hewlett devices.

Paragraph 27 to 41 describe the apparatus of figures 6 to 8, which with the exception of element (n) of figure 6 that is substituted for the filter 33-34 of Hanna to perform the same function. The examiner believes it to be the same with the possibility that certain elements have been replaced by equivalents as the apparatus disclosed in the Hanna, Robinson and Hewlett patents. Certainly, the result produced thereby is the same and it is produced in the same manner.

The above mention paragraphs with the exceptions of paragraph 17 have been rewritten by applicant to clarify the language.

Paragraphs 42 to 52 describe the particularly delay network, illustrated in figures 9 to 15, which governs the time action of the control circuit as specified; as far as can be determined *this is the real invention set forth over the prior art.*

Original claims 1 to 24 are not believed to add any disclosure, in addition to that set forth in the specification.

Consider claim 49 which was inadvertently allowed: "An apparatus for producing a photographic sound record of the variable width type comprising means for directing a beam of light on to a moving film so as to form a transversely disposed narrow strip of light on the film" is the recording optical element 8-10-12-15 of the Hewlett patent. "Means actuated by a sound responsive current for varying the length of the strip of light in accordance with the

amplitude of the sound "is indefinite, and may be either the speech circuit or the biasing circuit, because both vary the length of the strip of light in accordance with the am-
plitude of the sound. "A thermionic tube arranged
50 so that its plate current actuates light varying
means" is tube 343 of Hewlett. "Means for applying a biasing potential to the grid of said tube" is the speech circuit and also the biasing circuit of Hewlett. "Means actuated by the rectified portion of the sound responsive current for controlling said biasing potential in accordance with the volume of the sound so as to cause the plate current of the tube to vary in accordance with the volume of the sound" is the network 31, 32 and 36 to 38 of Hewlett; and can not be read on figure 7 of applicant drawing, because his means is q′ r q which is beyond the plate of the tube. This means is so indefinite that it may be the rheostat 39 of Hanna, but "actuated by" implies that it is the low pass filter. Since this means is the last of the elements positively set out, it is clear that the combination is old. "The apparatus being so adjusted that the zero line of the sound trace takes up such an initial position relatively to the sound tract that, when the plate current attains a zero value, the zero line moves from said initial position into the outer line of the sound track," is the normal adjustment of the oscillograph for standard recording as previously pointed out in this statement, and is not patentable subject matter. "Said apparatus including an oscillograph for directing the beam of light on to the film and for swinging the beam in accordance with the amplitude of the sound" is 11 of Hewlett. "In which loop the moving system of the oscillograph is connected in the plate circuit of the thermionic tube in series with two ohmic or inductive resistances which are arranged one on each side of the loop, with a condenser connected across the said re-
sistances and the loop, in order to prevent current of
51 audible frequencies in the plate circuit from affect-
ing the means position of the moving system of the oscillograph", states that the low pass filter required to produce the intensity varying current from the rectified audio current of the rectifier is operatively connected between the rectifier and the oscillograph. The condenser must bridge the resistances connected in series with the

loop and biasing circuit in order to by pass the audio in the biasing circuit, for otherwise it would by pass the speech current from the loop and render the device inoperative. This filter is 33-34 of Hanna, 37 to 40 of Robinson and 31-32-36 to 38 of Hewlett. Further, this means is already claimed in line 9. The examiner was in error in allowing this claim, as he read into it the particular delay network elements, which are not there upon analysis. Now, it is clear that the claim should be rejected, and it is recommended that it be so done, as not patentably distinguishing from the normal operation of the Hanna, Robinson and Hewletts patents.

Claim 56 was rejected on the Newlett patent because the last clause of the claim "whereby the mean position about which the mirror is oscillated by the influence of the varying current into which the sounds are converted, is altered in dependency of the magnitude of the sound amplitudes so as to cause the zero line of the recorded sound to be displaced transversely to the film from the initial position at one edge of the film towards the middle of the same at a rate *increasing* for *increasing amplitudes* of the recorded sound" does not define the real invention of a greater increase in the bias than the normal increase for increasing amplitudes of the recorded sound. It is clear that this feature of the claim reads on the normal operation of the Hanna, Robinson and Hewlett patents.

52 An invention of this type is difficult to particularly point out and distinctly claim in conformance with R. S. Sec. 4888. And prima facia, it appears that the system is old and applicant should be limited to claims defining his particular element. However, the result produced when this particular element is used is different or modified from the results produced by the Hanna, Robinson and Hewletts patents, and on this ground it is believed that applicant is entitled to system claims including his particular delay network. Exclusive of this particular delay network, there is believed to be no doubt, but that the system is disclosed by the Hanna, Robinson and Hewletts patents.

Claims 54, 58 and 59 are believed to be properly allowed. This completes the discussion of the claims of the final rejection. The claims of the amendment of June 11, 1936 entered for purposes of appeal will now be discussed.

Claim 65 is rejected as failing to particularly point out and distinctly claim the invention in conformance with R. S. Sec. 4888 in that the device claimed is inoperative unless the inversely varying current means is included in the claim, when a "rate of decrease" line 13 is specified with "increase of the sound intensity" lines 14 and 15.

Claim 66 and 67 which depend upon claim 65 are accordingly rejected as dependent upon a rejected claim. These claims will be allowable if claim 65 is made allowable.

Claim 68, appear to be allowable.

Claim 70 is rejected as failing to particularly point out
and distinctly claim the invention in conformance with
R. S. Sec. 4888, because "the electrical constants of the
rectifier and smoothing circuit being so adjusted that the
time constant of the total rectifying circuit is of
53 smaller value when the rectifier is operative than
when it is inoperative" is vague and indefinite to
the extent that the invention is not particularly pointed out
and defined. A comparison between the time constants
during operation and inoperation is meaningless, because
during periods of inoperativeness the time constant does
not exist. Further, what constitutes the "Total rectifying circuit" is not specified.

Claims 71 appears to be allowable.

Claim 72 is rejected as fully met by the Hanna, Robinson and Hewlett patents. The claim reads directly on the references as it is composed of two steps, the recording of the sound record and the recording of the volume record. "Holding the variations of the average exposure between predetermined lower and upper limits" is a required normal adjustment of the recorder in order that the record may be confined to the record track area allotted therefor.

Claim 73 and 74 are rejected as depending upon rejected claim 72. If rewritten to include claim 72 they would not be allowable because the additional features here set forth are adjustment of the devices of claims 72.

Claim 75 is rejected as dependent upon rejected claim 72 and if rewritten to include claim 72 it would not be allowable as a method claim, because the delay network does not add a step to the method of recording the sound, but modifies the step of recording the volume record by the function of the network here set forth.

Claim 76 is rejected as fully met by the Hanna, Robinson and Hewlett patents. The claim reads directly on the references.

Claim 77 and 79 are rejected as depending upon rejected claim 76. If rewritten to include claim 76 they would not be allowable because the additional features here set
54 forth are adjustments of the device of claim 76. The use of the inversely varying means of claim 79 has already been discussed in this statement.

In view of the above reasons it is believed that claims 54, 58, 59, 68, 69 and 71 have been properly allowed and that claims 56, 65 to 67, 70 and 72 to 79 have been properly rejected. The recommendation as to claim 49 is believed to be properly made.

C. J. SPENCER,
*Examiner*

55 *Decision of Board of Appeals*

March 26, 1937

The applicants have appealed from the action of the examiner finally rejecting claims 49, 56, 65 to 67, inclusive, 70 and 72 to 79, inclusive.

Claims 49 and 65 may be taken as examples.

49. An apparatus for producing a photographic sound record of the variable-width type comprising means for directing a beam of light on to a moving film so as to form a transversely disposed narrow strip of light on the film, means actuated by a sound responsive current for varying the length of the strip of light in accordance with the amplitude of the sound, a thermionic tube arranged so that its plate current actuates light varying means, means for applying a biasing potential to the grid of said tube, means actuated by a rectified portion of the sound responsive current for controlling said biasing potential in accordance with the volume of the sound so as to cause the plate current of the tube to vary in accordance with the volume of the sound, the apparatus being so adjusted that the zero line of the sound trace takes up such an initial position relatively to the sound track that, when the plate current attains a zero value, the zero line moves from the said initial position into the center line of the sound track, said ap-

paratus including an oscillograph for directing the beam of light on to the film and for swinging the beam in accordance with the amplitude of the sound, in which the loop of the moving system of the oscillograph is connected in the plate circuit of the thermionic tube in series with two ohmic or inductive resistances, which are arranged one on each side of the loop, with a condenser connected across the said resistances and the loop, in order to prevent current of audible frequencies in the plate circuit from affecting the means position of the moving system of the oscillograph.

65. A system for recording sounds on a light sensitive film comprising means for converting the sounds into a varying electrical current, a light source, means to concentrate a bundle of rays from said light source onto the surface of the film to form thereon a transversely disposed linear strip of light, means to cause said bundle of rays to vary so as to cause the exposure of the film to vary in accordance with the volume of the sound, a rectifier rectifying a portion of said varying electrical current, and a circuit through which the said rectified current influences the sound recording means to cause the said bundle of rays to oscillate dependent on the volume of the sound to be re-
corded, the electrical constants of at least one of the
56 circuits through which the rectified current acts upon
the sound recording member being of such a value
that the rate of decrease of the current acting upon the recording means is greater during increase of the sound intensity than the rate of increase of the peak value of the alternating current.

The references relied upon are:

| | | |
|---|---|---|
| Sacia, | 1,623,756, | Apr. 5, 1927, |
| Hewlett, | 1,853,812, | Apr. 12, 1932, |
| Robinson, | 1,854,159, | Apr. 12, 1932, |
| Hanna, | 1,888,724, | Nov. 22, 1932, |

The disclosure is said to relate to methods of producing photographic sound records on films in which the sound to be recorded is first converted into alternating current to control a second recording device. In this method a light beam is directed onto a film to form a transversely disposed narrow strip of light, the length of the strip being varied by said alternating current about an average value according to the amplitude of the individual sound wave. It is stated that irregularities and scratches in the transparent portion of the film cause disturbing noises during reproduction called "background noises". It is stated that in the known art it has been proposed to actuate the recording device not only by an alternating sound responsive current but also by direct current which is influenced by a rectified portion of the sound responsive or alternating current so as to cause the average length of the light strip formed on the film to vary dependent on the volume of the sound whereby on the sound reproducing film prepared from the original sound record the mean transparency of the sound track decreases when the volume of the recorded sound decreases, thereby producing the so-called noiseless sound record.

57 It is stated that to avoid distortion in the reproduced sounds the average length of the strip of light must not exceed a value which is equal to the difference between the value or length of the light strip during silent periods and 50% blackening of a transversal element of the sound track, otherwise the length of the light strip would, when the volume of the sound is at a maximum, pass outside the range for the maximum degree of modulation of the exposure.

To attain applicant's object the direct current is adjusted to such magnitude that it attains zero value when the magnitude of the alternating or sound responsive current reaches a maximum value, corresponding to the maximum value of sound or something less than the maximum. In this method the direct current and sound recording device are so adjusted that when the sound responsive current is zero or minimum value, the direct current maintains the sound recording device in such position that the zero line of the sound trace is located near to one edge of the sound track.

It is further stated in the specification that a variation of the average transparency of the sound track corresponding to an increase of the volume of the sound should appear as quickly as possible in order that the peaks of the amplitude of the recorded variation representing the first waves of the sound of increased volume should not be cut off. It is also stated that this might happen because the

peaks extend outside the border line of the sound track of a variable width record and that it will not happen if the zero line is shifted quickly. On the other hand, when the volume of sound decreases, the zero line should not be shifted too quickly towards the border lines because the
sound might be cut off. It is further stated that the
58 adjustment of the system to govern the sound re-
cording member can be attained by the mutual adjustment of the coefficients of conductivity of the circuit or one or more of the circuits through which the rectified current is transferred or is caused to actuate the sound recording member in such a manner that the variations in the rectified current are effected more quickly when the said current increases than when it decreases.

Claim 49 has been rejected as not patentably distinguishing from the normal operation of the devices of the patents to Hanna, Robinson and Hewlett, the structure and operation of which patented devices have been applied in detail by the examiner and need not be repeated here.

Appellants point out that the examiner is mistaken as to the limitation that claim 49 called for the zero line moving from the initial position into the *outer* line when actually it is moved into the *center* line of the sound track. The chief argument of appellants for patentability of this claim seems to be that no prior art has two limits within which the zero line may be moved. With respect to this argument, it appears that the systems of the patentees of necessity have two limits and that this claim does not differ patentably from the art in that respect.

The examiner states that the means actuated by sound responsive current for varying the length of the strip of light in accordance with the amplitude, as called for in claim 49 is indefinite and may be either the speech circuit or the biasing circuit. It is not seen that this renders the language indefinite but merely broad. The other criticisms of this claim by the examiner as to duplication of the member in line 9 have been explained by applicants. It seems,
however, that the claim does not patentably distin-
59 guish over the references cited by the exmainer.

With respect to the rejection of claim 56, appellants point out that the examiner has not quoted all of the claim and that the amendment thereto comprising cancelled claim 57 of amendment H, September 19, 1935, and which the examiner stated in paper No. 18 if rewritten would be allowable, has been omitted in the examiner's consideration of this claim. It appears that the claim 56 which the examiner is acting on in his statement is not on appeal before us and that the present claim 56 of the application has actually been held to be allowable by the examiner. Under the circumstances as understood, present claim 56 of the application is considered allowable.

Claim 65 has been rejected as failing to patentably point out and distinctly claim the invention in accordance with R. S. 4888 in that the device claimed is inoperative unless the inversely varying current means is included in the claim when a rate of decrease, line 13, is specified with increase of the sound intensity, lines 14 and 15. It is noted that the claim states that the rate of decrease of the current acting upon the recording means appears to indicate that the movement of the zero line toward the center of the film is greater during increase of sound intensity than the rate of increase of the peaked value of the alternating current. As understood, this limitation in the claim says in effect that the zero line moves toward the center line of the sound track with greater rapidity than the increase in the volume of the sound.

Appellants argue with respect to this rejection that as understood the objection is to the effect that both the rate of decrease and increase of the biasing current should be defined and that there is nothing in the prior art that necessitates such a limitation. It is argued that in all prior
structures of zero line shift systems the zero line
60 was shifted uniformly and always at the same rate
at which the current decreased or increased, while
appellants' shift more quickly during the increase in the amplitude and more slowly during the decrease in the amplitude. Appellants state that the examiner seems to think that both kinds of shift must be defined since one can never be used without the other and that he does not state on what he bases his conclusion. Finally, it is argued that claim 65 defines a system in which the zero line is shifted more quickly than the variation in the sound amplitude when the sound amplitude increases. It is believed that it is not necessary to state the rate of decrease or shift of the

peaks extend outside the border line of the sound track of a variable width record and that it will not happen if the zero line is shifted quickly. On the other hand, when the volume of sound decreases, the zero line should not be shifted too quickly towards the border lines because the sound might be cut off. It is further stated that the
58 adjustment of the system to govern the sound re-
cording member can be attained by the mutual adjustment of the coefficients of conductivity of the circuit or one or more of the circuits through which the rectified current is transferred or is caused to actuate the sound recording member in such a manner that the variations in the rectified current are effected more quickly when the said current increases than when it decreases.

Claim 49 has been rejected as not patentably distinguishing from the normal operation of the devices of the patents to Hanna, Robinson and Hewlett, the structure and operation of which patented devices have been applied in detail by the examiner and need not be repeated here.

Appellants point out that the examiner is mistaken as to the limitation that claim 49 called for the zero line moving from the initial position into the *outer* line when actually it is moved into the *center* line of the sound track. The chief argument of appellants for patentability of this claim seems to be that no prior art has two limits within which the zero line may be moved. With respect to this argument, it appears that the systems of the patentees of necessity have two limits and that this claim does not differ patentably from the art in that respect.

The examiner states that the means actuated by sound responsive current for varying the length of the strip of light in accordance with the amplitude, as called for in claim 49 is indefinite and may be either the speech circuit or the biasing circuit. It is not seen that this renders the language indefinite but merely broad. The other criticisms of this claim by the examiner as to duplication of the member in line 9 have been explained by applicants. It seems, however, that the claim does not patentably distin-
59 guish over the references cited by the exmainer.

With respect to the rejection of claim 56, appellants point out that the examiner has not quoted all of the claim and that the amendment thereto comprising cancelled claim 57 of amendment H, September 19, 1935, and which the examiner stated in paper No. 18 if rewritten would be allowable, has been omitted in the examiner's consideration of this claim. It appears that the claim 56 which the examiner is acting on in his statement is not on appeal before us and that the present claim 56 of the application has actually been held to be allowable by the examiner. Under the circumstances as understood, present claim 56 of the application is considered allowable.

Claim 65 has been rejected as failing to patentably point out and distinctly claim the invention in accordance with R. S. 4888 in that the device claimed is inoperative unless the inversely varying current means is included in the claim when a rate of decrease, line 13, is specified with increase of the sound intensity, lines 14 and 15. It is noted that the claim states that the rate of decrease of the current acting upon the recording means appears to indicate that the movement of the zero line toward the center of the film is greater during increase of sound intensity than the rate of increase of the peaked value of the alternating current. As understood, this limitation in the claim says in effect that the zero line moves toward the center line of the sound track with greater rapidity than the increase in the volume of the sound.

Appellants argue with respect to this rejection that as understood the objection is to the effect that both the rate of decrease and increase of the biasing current should be defined and that there is nothing in the prior art that necessitates such a limitation. It is argued that in all prior structures of zero line shift systems the zero line 60 was shifted uniformly and always at the same rate at which the current decreased or increased, while appellants' shift more quickly during the increase in the amplitude and more slowly during the decrease in the amplitude. Appellants state that the examiner seems to think that both kinds of shift must be defined since one can never be used without the other and that he does not state on what he bases his conclusion. Finally, it is argued that claim 65 defines a system in which the zero line is shifted more quickly than the variation in the sound amplitude when the sound amplitude increases. It is believed that it is not necessary to state the rate of decrease or shift of the zero line in order to define a patentable limitation over the art as has been pointed out by appellants and we consider this claim allowable.

Claims 66 and 67 are stated by the examiner to be dependent upon claim 65 and to be allowable if claim 65 is allowable.

Claim 70 has been rejected as failing to point out invention over the statute because "the electrical constants of the rectifier and smoothing circuit being so adjusted that the time constant of the total rectifying circuit is of smaller value when the rectifier is operative than when it is inoperative" is vague and indefinite to the extent that the invention is not particularly pointed out and defined.

Appellants state that the claim describes the characteristics of the rectifying circuit through which the bias can be applied to the oscillograph and that it should be allowed because no art is cited negativing its novelty or patentability. It is argued that the examiner's statement that during periods of inoperativeness the time constant does not exist is erroneous because the combination of the
61 rectifier and smoothing circuit can vary and have currents flowing in it although the rectifier itself is inoperative. Appellants' argument seems to be somewhat involved as is the claim and it is not clear to us what the claim means and for the reasons given by the examiner the rejection appears to have been properly made.

Claim 72 has been rejected on the patents to Hanna, Robinson and Hewlett. Appellants concede that all the elements of this claim, except the last, are found in the prior art, but contend that the last element calls for the step of holding the variations of the average exposure, that is, the zero line between predetermined lower and upper limits because in all prior structures only one limit is set, the zero line being permitted to shift past the center line of the track. It is not seen that the fact that the zero line is permitted to shift past the center line indicates that it does not have a limit somewhere beyond the center line. The rejection of this claim appears to have been properly made.

Claims 73 and 74 are dependent upon claim 72 and are rejected for the same reason.

Claim 75 has been rejected as dependent upon claim 72 with the statement that if rewritten to include claim 72, it would not be allowable because the delay network does not add a step to the method of recording the sound but modifies the step of recording the volume record by the function of the network. Appellants argue that claim 75 adds the limitation that the average exposure is varied more rapidly than the sound volume increases and more slowly than said amplitude when the volume decreases. It is considered that this claim should be allowed.

Claim 76 has been rejected on the patents to Hanna, Robinson and Hewlett. For the reasons indicated by the examiner, this claim appears to have been properly 62 rejected and claims 77 to 79, inclusive, are considered to present no patentable limitations over the references for the reasons given.

For the reasons indicated, the decision of the examiner is reversed as to claims 56, 65, 66, 67 and 75 and is affirmed as to the remainder of the appealed claims.

BOARD OF APPEALS

HENRY VAN ARSDEL,
*Assistant Commissioner*

E. T. MORGAN
*Examiner-in-Chief*

F. J. PORTER
*Examiner-in-Chief*

March 26, 1937

63 *Petition for Rehearing Before Board of Appeals*

Filed May 10, 1937.

I hereby petition for a rehearing in the above entitled matter which was decided by the Board of Appeals on March 26, 1937. The reason for the delay is because the inventors are residing in Copenhagen and communication with them was necessarily slow.

It is submitted that a rehearing is likely to convince the Board of Appeals that the conclusions they have reached are erroneous for the following reasons:

The Board sustained the final rejection of claim 72 on the patents to Hanna, Robinson and Hewlett. Claims 73 and 74 are dependent on claim 72 and add the limitations that the lower limit of the average exposure is zero (claim 73) and that the upper limit of the average exposure is midway between zero and full exposure (claim 74).

The Board apparently overlooked these limitations contained in the two claims since the decision merely says:

"Claims 73 and 74 are dependent on claim 72 and are rejected for the same reason".

It is submitted that irrespective of the disposition that is made of claim 72, claims 73 and 74 should be allowed, and that at least a claim be allowed that combines all the elements cited in claims 72, 73 and 74.

Similarly, claims 77, 78 and 79 contain limitations over claim 76 which was rejected and which, it is believed, render these claims patentable or at least render patentable a claim containing all the limitations of claims 76, 77 and 78. 64

It is also believed that as to the other claims under rejection, the Board of Appeals failed to give due weight to the essential differences that exist between the structure of the prior art and those of appellants.

Respectfully submitted,

PAUL KOLISCH
*Attorney for Appellants*

New York, May 8, 1937.

## 65 *Decision of Board of Appeals on Petition for Rehearing*

May 14, 1937

Applicants have petitioned for a rehearing of the decision of the Board of Appeals dated March 26, 1937.

It is argued that claims 73 and 74 are dependent on claim 72 and add the limitations that the lower limit of the average exposure is zero and that the upper limit of the average exposure is midway between zero and full exposure. In his statement the examiner, in substance, held that these claims 73 and 74, if rewritten to include claim 72, would not be allowable because the additional features comprised adjustment of the devices of claim 72.

The rejection of claim 72 was discussed in the decision and it was pointed out that it was not seen that the fact that the zero line is permitted to shift past the center indicates that it does not have a limit somewhere beyond the center line. Claims 73 and 74 appeared to provide merely an arbitrary variation within these limits. To provide the upper and lower limits within the same general range indicated in claim 72 is thought to amount to nothing more than an arbitrary positioning or adjustment of the limits expressed in claim 72 and such positioning is considered not to amount to a patentable improvement.

The limits in claims 77, 78 and 79 over claim 76 are of the same general nature as those in claims 73 and 74 and were considered to be unpatentable for the same reasons.

No reason is seen for modifying our decision and the petition is accordingly denied.

BOARD OF APPEALS

HENRY VAN ARSDEL
*Assistant Commissioner*

E. T. MORGAN
*Examiner-in-Chief*

F. J. PORTER
*Examiner-in-Chief*

May 14, 1937.

**April 5, 1927.** **1,623,756**

C. F. SACIA

RECORDING AND REPRODUCING OF SOUNDS

Filed May 5, 1924

Fig. 1

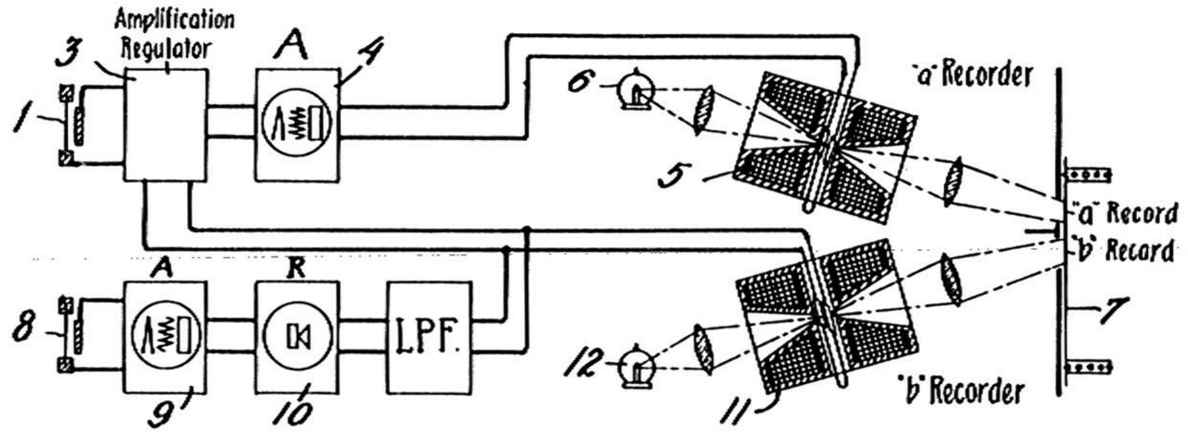
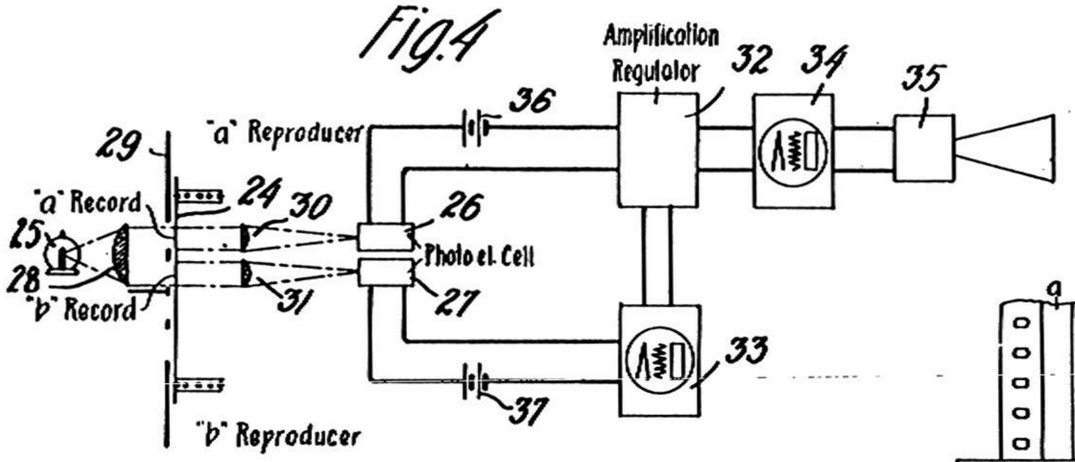


Fig. 4



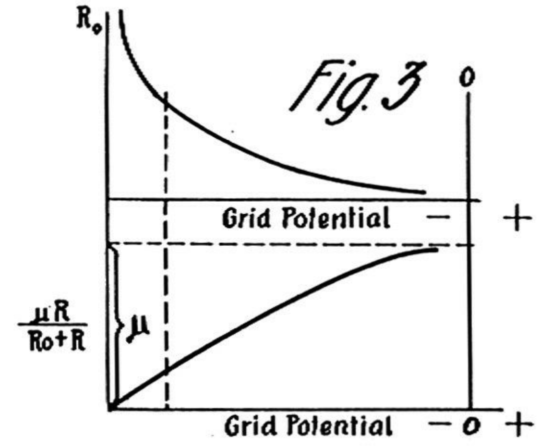


Fig. 5

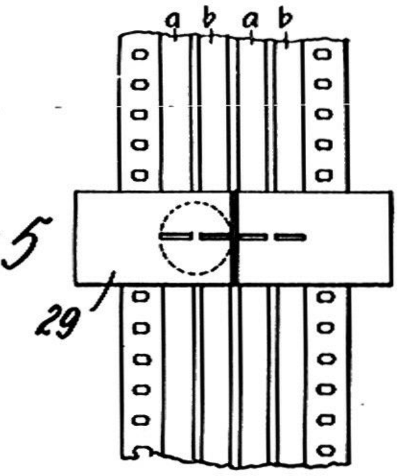
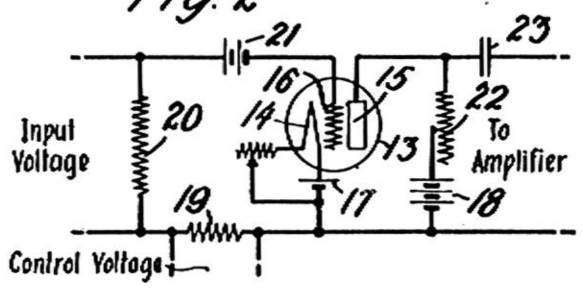


Fig. 2



Inventor:
Charles F. Sacia

by E. W. Adams Att'y

**Patented Apr. 5, 1927.** **1,623,756**

# UNITED STATES PATENT OFFICE.

CHARLES F. SACIA, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

## RECORDING AND REPRODUCING OF SOUNDS.

Application filed May 5, 1924. Serial No. 711,033.

This invention relates to sound recording and reproducing systems, and particularly to methods of and means for recording and reproducing sounds having a wide range of intensities.

As is well known, there is a fairly definite limit to the range of intensity of spoken or musical sounds that can be satisfactorily recorded by present known means, such as the phonograph record and the photographic film. This is due in part at least, to overload distortion at large amplitudes and to the suppression of important high frequency components by the insufficient resolving power of the recording material, the phonograph disc, the photographic film, etc. It is desirable to greatly increase the intensity range of recording, for example, in the case of "talking moving pictures" and the good quality reproduction of orchestra music.

An object of this invention is to provide a method of and means for accurately recording sounds having a wide range of amplitudes using present known means.

A further object is to provide a method of and means for accurately reproducing the original sounds from the records obtained in such a recording process.

The invention provides for making two records of the sounds, (*a*) a record of the sound reduced to an arbitrary or artificial standard intensity irrespective of the actual intensity of the sound itself, and (*b*) a record of the intensity of the sound. Furthermore, it provides that in the production of the (*a*) record the instantaneous amplitudes of the recorded sound variations shall be controlled by the same energy which produces the (*b*) record. In the reproduction, the two records are utilized, the output of the (*a*) record being controlled by the output of the (*b*) record in such a way that variations in intensity, which were removed in the production of the (*a*) record, are reinserted and an exact reproduction of the original sounds both in wave form and in intensity is obtained.

These methods apply most readily to electrical means of recording and reproducing sounds and will be illustrated in that way, although they are not necessarily limited to such means. A recording circuit comprising a telephone transmitter, an amplifier, a vacuum tube rectifier and a low pass filter may be used for transforming the sound energy into electrical energy and for furnishing the current for operating a suitable recording device for making the (*b*) record. The variations in the rectified current output of this circuit will be directly proportional to the variations in the intensity of the sounds received by the transmitter and the (*b*) record will, therefore, be an accurate record of these variations in intensity. In obtaining the (*a*) record, that is, a record of the sound reduced to a standard constant intensity, the invention makes use of the fact that the amplification of a thermionic amplifier of the audion type depends upon the voltage impressed upon the grid or input circuit. A recording circuit comprising a telephone transmitter, an amplification regulator and an amplifier in connection with a suitable recording device is used for making the (*a*) record. The telephone transmitter used in the (*a*) circuit may be the same one used in the (*b*) circuit, or a separate transmitter may be used for each circuit as shown in the accompanying drawing. The output of the low pass filter in the auxiliary recording circuit used for making the (*b*) record, described above, is used for furnishing low frequency, rectified voltage to regulate the potential on the grid of the amplification regulator in the (*a*) circuit. If this regulation is such that loud sounds received by the transmitter are weakly amplified and faint sounds strongly amplified, it is apparent that the output of the circuit recorded on the (*a*) record will be a record of the sound wave but reduced to a constant amplitude, the variations in intensity having been smoothed out. In the reproduction, however, the sound output of the (*b*) record transformed into electrical energy, amplified if necessary, is used to furnish the voltage for regulation of the potential on the grid of the amplification regulator, the regulation, however, being the reverse of that in the recording system. The output of the (*a*) record is also impressed on the input circuit of the amplification regulator. Then, the variations in intensity removed in the making of the (*a*) record will be reinserted, and the resulting output supplied to a suitable sound reproducer will reproduce the original sounds without distortion.

Certain features and the general nature of the invention have been briefly stated above. This and other features and objects will be more clearly understood from the following detailed description of particular systems embodying the invention and illustrated in the accompanying drawings.

Fig. 1 is a diagrammatic representation of a sound recording arrangement embodying the invention. Fig. 2 is a schematic representation of the amplification regulator used in the recording and reproducing circuits shown in Figs. 1 and 4, respectively. Fig. 3 shows the characteristic curves of an electron discharge device for illustrating the operation of the amplification regulator shown in Fig. 2. Fig. 4 is a diagrammatic representation of a sound reproducing arrangement embodying the invention. Fig. 5 shows a section of film indicating one form of sound record obtained using the arrangement shown in Fig. 1.

Referring to Fig. 1, a source of variations, represented by the telephone transmitter 1 is connected to the input circuit of the amplification regulator 3, the output circuit of which is connected to the input circuit of the amplifier 4. The output circuit of the amplifier 4 is connected to the movable wires of a light valve 5 arranged to vary the quantity of light from a source 6 falling on a film 7, in accordance with the variations of current received. Similarly, the source of signals, represented by the transmitter 8 is connected to the input circuit of the amplifier 9, the output circuit of which is connected to the input circuit of a vacuum tube rectifier 10. The output circuit of the rectifier 10 is connected to the input circuit of a low pass filter LPF, the output circuit of which is connected to the movable wires of a light valve 11 arranged to vary the quantity of light from a source 12 falling on the film 7, in accordance with variations in the current received. The output circuit of the low pass filter LPF is also connected to the control terminals of the amplification regulator 3.

The transmitters 1 and 8 are preferably of the type described in the article entitled "The Sensitivity and Precision of the Electrostatic Transmitter for Measuring Sound Intensity," by E. C. Wente, published in the Physical Review for May, 1922, and their circuits are preferably as described in that article. The amplification regulator 3 is described later. The amplifiers 4 and 9 may be of the well known three-electrode vacuum tube type. The rectifier 10 may also be of the three electrode vacuum tube type, the grid of which is maintained predominantly negative. The recorders 5 and 11 may be any suitable type but are preferably of the type shown in Fig. 1 and illustrated and described in detail in the copending application of E. C. Wente, Serial No. 635,886, filed May 1, 1923, which type is adapted for making sound records on photographic films. The low pass filter LPF may be of the type disclosed in U. S. Patent to G. A. Campbell, No. 1,227,113, dated May 22, 1917, and is preferably designed to pass frequencies ranging from zero to the neighborhood of 10 cycles, or in some cases up to 50 cycles depending on the nature of the sound to be recorded.

The circuit and apparatus having been generally described, its exact nature will be more clearly understood by a detailed description of its operation. Sound variations received by the transmitter 1 are supplied to the input circuit of an amplification regulator 3, repeated in its output circuit, and amplified by the amplifier 4. The corresponding variations in current in the output circuit of the amplifier 4 are transmitted through the conductors of the light waves 5 causing variations in the width of the slot in the valve 5 corresponding to the variations in current received, thereby varying the quantity of light from the source 6 transmitted through the slot. This light is focused on a continuously moving film 7 to produce a series of striations of varying intensity, corresponding to the sound variations, constituting the (*a*) record of the sounds to be recorded. In a similar manner, sound variations received by the transmitter 8 are supplied to the input circuit of an amplifier 9 and repeated in its output circuit. The variations in the output circuit of the amplifier 9 are supplied to the input circuit of the rectifier 10, and the corresponding rectified variations in its output circuit are transmitted through the low pass filter LPF to the light valve 11, which in the same manner as described for light valve 5, causes the (*b*) record to be recorded on the film. The variations recorded on this record will be directly proportional to the variations in intensity of the sounds received by the transmitter 8. The output of the low pass filter LPF besides furnishing the current for operating the recorder 11 for making the (*b*) record is connected to the input circuit of the amplification regulator 3 in the circuit for making the (*a*) record to furnish a slowly varying rectified voltage to the grid of the regulator to control its amplification. The amplification regulator, which is described in detail below, operates in the recording system so as to cause weak amplifications of loud sounds and strong amplifications of faint sounds. Thus, the (*b*) record will be a record of the variations in intensity of the sounds received by the transmitter, while the (*a*) record will be a record of the sounds reduced to a constant standard intensity. The two records may be on the same unit (possibly even on the same track), as illustrated in Fig. 1, or they may be made on different units suitably synchronized. The former method which is the preferred method, has been specifically illustrated.

It may be necessary to cause operation of the circuit used for making the (*a*) record to lag slightly behind the operation of the circuit for making the (*b*) record to insure due action of the amplification regulator. This time lag may be obtained by the use of an electrical network, or in fact by any system which possesses a phase lag proportional to the frequency, for if the lag angle is K times the frequency, the time lag is $\frac{K}{2\Pi}$ second.

The amplication regulator used in the recording system described above, and also in the reproducing system to be described later, will now be explained in more detail. The theory covering the operation of the regulator can be best shown by consideration of the characteristic curves of a vacuum tube amplifier as shown in Fig. 3. Suppose a vacuum tube is connected to a low impedance output the amplitude of the superimposed alternating current waves being small enough not to be distorted by this impedance relation, then its characteristic curves will be like those shown in Fig. 3. The upper curve gives the relation between the internal resistance of the tube and the grid potential, and the lower curve the relation between the amplification of the tube and the grid potential. The amplification is

$$A=\frac{\mu R}{R_o+R},$$

where $\mu$ is the amplification constant of the tube, R is the external resistance, and $R_o$ is the internal resistance of the tube. As shown by the curves, the amplification is approximately inversely proportional to the internal resistance of the tube, and over a considerable range can be made to be proportional to the grid voltage. Therefore, a negative voltage applied to the grid will cause a decrease in the plate current, an increase in the internal resistance, and hence a decrease in the amplification in proportion to the applied grid potential within the range indicated.

Referring now to the circuit of the amplification regulator shown in Fig. 2, 13 is a vacuum tube amplifying device comprising a cathode 14, anode 15 and a control electrode 16. The cathode 14 is heated to incandescence by battery 17, and is maintained positive with respect to control electrode 16 by battery 18. The input circuit of the amplifier 13 includes the cathode 14, resistance 19, resistance 20, battery 21, and the control electrode 16. The output circuit of the amplifier 13 includes the anode 15, the adjustable resistance 22, the battery 18, and the cathode 14. The adjustable resistance 22 may be used for varying the external resistance in the output circuit.

In operation in the circuit as shown in Fig. 1 sound variations from the transmitter 1 are impressed on the input circuit across the resistance 20 and are repeated in the output circuit of the tube. The output of the low pass filter LPF, is connected across the resistance 19 to furnish the varying rectified control voltage for varying the grid potential. The leads from the low pass filter LPF are so connected, that an increase in the drop across the resistance 19, caused by an increase in the current received from the low pass filter LPF, will cause an increase in the negative voltage applied to the grid, an increase in the internal resistance of the tube, and therefore a decrease in the amplification. However, as mentioned above, when the amplication regulator is used in the reproducing circuit shown in Fig. 4, the leads from the amplifier 32 are so connected across the resistance 19 that an increase in the drop across the resistance 19, caused by an increase in the amplified current received in the reproduction of the (*b*) record, will cause a decrease in the negative voltage applied to the grid, a decrease in the internal resistance of the tube, and, therefore, an increase in the amplification. When the amplification regulator is used in the recording system of Fig. 1, the direct current component of its output current is prevented from passing to the amplifier 4, by the condenser 23. Likewise, when the regulator is used in the reproducing circuit of Fig. 4, the direct current component of its output current is prevented from passing to the amplifier 34 by the condenser 23. Thus, in the recording system shown in Fig. 1, loud sounds received in the transmitter which cause weak amplification and faint sounds strong amplification, while in the reproducing system shown in Fig. 4, the regulating action is reversed. This regulating device may be made part of the first stage of the amplifier, as shown in Fig. 2, or may be used as a separate unit in conjunction with an amplifier. The regulation can be applied to more than one step if desired, hence a very large range of amplification can be obtained.

The reproducing system shown in Fig. 4 will now be described. The film 24 is shown positioned between a light source 25 and the photoelectric cells 26 and 27. This film, shown in more detail in Fig. 5, is a positive made from a negative film produced in the recording process, and contains on its surface striations corresponding to the (*a*) and (*b*) records. Light rays from the source 25 passing through the lens 28, apertures in the opaque screen 29, and transparencies in the film 24, are focused by lenses 30 and 31 upon the photoelectric cells 26 and 27, respectively. The photoelectric cell 26 is connected to the input circuit of the amplification regulator 32. The photoelectric cell 27 is connected to the input circuit of an amplifier 33, the output circuit of which is also connected to the input circuit of the amplification regulator 32. The output circuit of the amplification regulator 32 is connected to the input circuit of another amplifier 34, the output circuit of which is connected to the sound reproducer 35. The amplifiers 33 and 34 and the amplification regulator 32 are similar to the corresponding apparatus described in connection with Figs. 1 and 2. The sound reproducer 35 may be of any suitable type for example, such as a telephone receiver or loud speaker.

The circuit and apparatus used in Fig. 4 having been generally described, its exact nature will be more clearly understood by a detailed description of its operation. The light rays from the source 25 transmitted through the lens 28 apertures in the opaque screen 29, and the transparency of the film 24, and focused on the photoelectric cell 26, cause the current from the battery 36 flowing through the photoelectric cell 26 to vary in accordance with the striations correspnding to the (*a*) record on the film 24, which variations are impressed upon the input circuit of the amplification regulator 32. Similarly, the light rays from the source 25 transmitted through the lens 28, other apertures in the opaque screen 29, and the transparency of the film 24, and focused on the photoelectric cell 27 by the lenses 30 and 31 cause the current from the battery 37 flowing through photoelectric cell 27 to vary in accordance with the striations corresponding to the (*b*) record on the film 24. These variations are impressed upon the input circuit of amplifier 33, repeated in its output circuit, and supplied to the grid of the amplification regulator 32, varying the amplification in accordance with the variations in the (*b*) record. The operation of the amplification regulator is the reverse of that obtained in the recording, as explained above in connection with the description of the operation of the amplification regulator shown in Fig. 3, the variations in intensity, which were removed in the production of the (*a*) record in the recording system, being reinserted. The variations in the output circuit of the amplification regulator 32 are amplified by the amplifier 34 and supplied to the sound reproducer 35, which reproduces the original sounds recorded over a wide range of intensity.

It may be necessary to cause the operation of the circuit including the photoelectric cell 26 and the amplification regulator 32 to have a slight phase lead over the operation of the circuit including the photoelectric cell 27 and the amplifier 33 to insure due action of the amplification regulator. This time lag may be produced by mechanical adjustment, by means of an electrical network, or by any system which possesses a phase lag proportional to the frequency.

The systems above illustrated and described should be construed merely as typical and not as limiting the invention, the scope of which is defined in the appending claims. Although for convenience of description, the (*a*) record has been referred to in the specification as reduced to a constant standard intensity or amplitude, this intensity or amplitude need not be constant, but may be arbitrarily changed to any desired value.

What is claimed is:

1. The method of recording waves which comprises producing a record of the variations in amplitude of the waves and producing another record of the structure of said waves modified as to amplitude.

2. The method of recording waves which comprises producing a record of the varying amplitudes of the waves and producing another record of the harmonic structure of said waves reduced to an arbitrary standard amplitude.

3. The method of recording waves which comprises producing a record of the amplitudes of the waves and producing another record of the instantaneous phase variations of said waves, said other record being reduced to an arbitrary amplitude.

4. The method of recording sound, which comprises producing a record of the variations in intensity of the sound and producing a second record of the sounds reduced to an arbitrary standard intensity.

5. The method of recording sound waves which consists in producing a record of the amplitudes of the sound waves, and producing a second record of the shape of the sound waves reduced to a constant amplitude.

6. The method of recording waves which comprises producing a record of the instantaneous amplitudes of the waves, and producing a second record of the structure of said waves, altered in accordance with the amplitudes of said waves.

7. The method of recording waves which consists in amplifying the waves, regulating the degree of amplification of said waves in accordance with variations in amplitude of said waves, utilizing said amplified waves for making a record of the harmonic structure of said waves, and producing another record of the variations in amplitude of said waves.

8. The method of recording waves, which comprises producing a uni-directional pulsating current varying in accordance with variations in the amplitude of the waves, utilizing said current to make a record of said variations in amplitude, amplifying said waves, utilizing said current also to control the degree of amplification inversely as the amplitude of said waves, and utilizing the amplified waves for making a second record of the waves.

9. In a recording system, a source of waves, means for recording the variations in amplitude of said waves, and means for recording the structure of said waves modified as to amplitude.

10. In a recording system, a source of waves of varying amplitudes, means for recording said amplitudes, and means for recording also the harmonic structure of said waves modified to an arbitrary standard amplitude.

11. In combination, a source of waves, means for producing a record representing the structure of said waves, means for controlling the amplitude of said waves in accordance with the intensity of sounds, and means for recording variations in said sound intensities.

12. A recording system comprising a source of waves of varying amplitudes, an amplifier supplied with said waves, means for regulating the degree of amplification imparted to said waves, a wave responsive device arranged to control said regulating means in accordance with variations in intensity of said waves and a recording device controlled by said amplifier.

13. A recording system which comprises a source of waves of varying amplitudes, an amplifier supplied with said waves, means for regulating the degree of amplification of said waves, a wave responsive device arranged to control said regulating means in accordance with variations in amplitude of said waves, a recording device controlled by said amplifier, and means for recording the variations in amplitude of said waves.

14. In combination, a source of waves, an amplifier supplied with said waves, means for supplying a uni-directional, pulsating voltage varying in accordance with the amplitude of said waves to said amplifier for regulating the degree of amplification of said waves, and a recording device controlled by said amplifier.

15. In a recording system, a source of waves, an amplifier supplied with said waves, means for producing a uni-directional, pulsating current of low frequency varying in accordance with variations in amplitude of said waves, a recording device controlled by said current, the degree of amplification of said waves supplied to said amplifier being also controlled by said current, and a second recording device controlled by said amplifier.

16. In a recording system, a source of sound waves, means for obtaining an amplified, rectified current varying in accordance with variations in the amplitude of said waves, a recording device controlled by said varying current, an amplifying device supplied with said waves a regulating device supplied with said rectified current for controlling the amplification of said waves supplied to said amplifying device in accordance with variations in said current, and a second recording device controlled by said amplifier.

17. In a recording system, a source of sound waves of varying intensity, a regulating device supplied with said waves, means for varying the amplification of said waves supplied to said regulating device inversely as the intensity of said waves, means for recording the waves as modified by said first mentioned means, and means for making a record of variations in amplitude of said sound waves.

18. A method of producing a wave from wave records which comprises regulating the output of a record of certain characteristics of a wave with the output of a record of other characteristics of said wave, and controlling a receiving device with the resultant output of said records so that said wave is reproduced with all of said characteristics.

19. A method of reproducing sound from two sound records upon which are recorded different characteristics of the same source of sound waves, one of said records representing the harmonic structure of a sound wave and the other of said records representing the varying amplitudes of said wave, which comprises transforming the output of each of said records into corresponding electrical variations, impressing the variations corresponding to the output of the first mentioned record on the input circuit of an amplifying device superimposing thereon the variations corresponding to the output of the second mentioned record of the amplitudes of said wave, regulating the amplification of said variations corresponding to said first mentioned record with the variations corresponding to said second mentioned record and transforming the resultant output of said amplifying device into sound energy.

20. In a reproducing system, a record representing certain characteristics of a wave, another record representing other characteristics of the same wave, a receiving device, and means for controlling said receiving device with the output of said records whereby a wave is produced having all of the characteristics of said wave.

21. In a reproducing system a record representing the varying amplitude of a wave,

another record representing the harmonic structure of said wave, and a receiving device controlled by said records whereby said wave is reproduced correct in wave form and amplitude.

22. In a reproducing system, a record of the amplitude of a sound wave, another record of the harmonic structure of said wave, a receiving device, and means for controlling said receiving device with said records whereby said wave is reproduced accurately in wave form and amplitude.

23. In a reproducing system, a record of the varying amplitudes of a sound wave, another record of the structure of said wave, means for controlling the output of said second mentioned record with the output of said first mentioned record so as to obtain a resultant output having the same amplitudes and the same wave form as said sound wave, and means for transforming said output into sound energy.

24. In a reproducing system, a record of the varying amplitudes of a sound wave, another record of the harmonic structure of said wave, means for transforming the output of each of said waves into electrical variations, means for amplifying the variations corresponding to the output of the first mentioned record, means for regulating the degree of amplification of the variations corresponding to the second mentioned record by superimposing thereon said amplified variations corresponding to said first mentioned record, means for amplifying the resultant output, and means for transforming said output into sound energy.

25. In a reproducing system, a record of the varying amplitudes of a sound wave, another record of the harmonic structure of said wave, means for transforming the output of each of said records into electrical variations, means for regulating the amplification of the variations corresponding to the second mentioned record with the variations corresponding to the first-mentioned record, and means for transforming the resultant variations into sound energy.

In witness whereof, I hereunto subscribe my name this 29th day of April A. D., 1924.

CHARLES F. SACIA.

April 12, 1932. C. W. HEWLETT 1,853,812

SOUND RECORDING

Filed Dec. 4, 1929

Fig. 1.

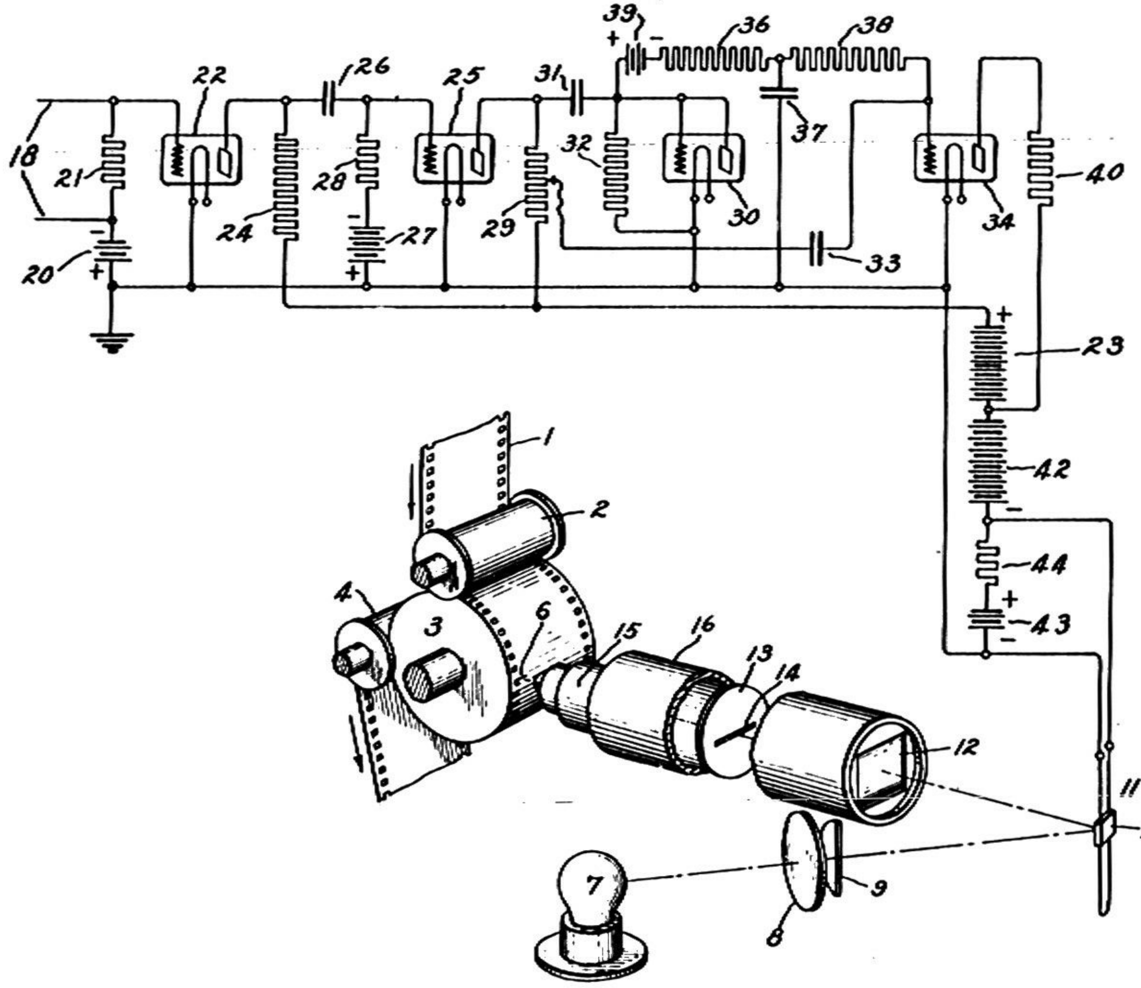
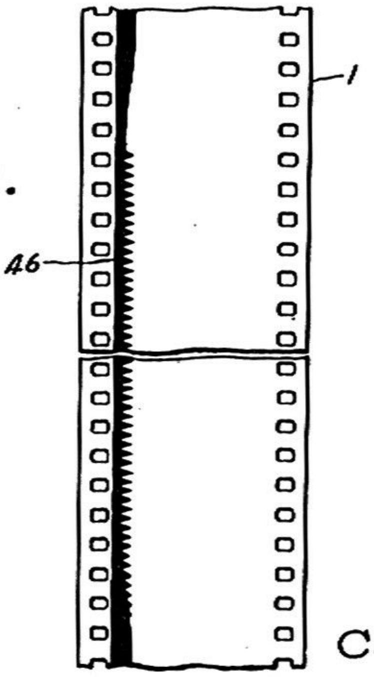


Fig. 2.



Inventor
Clarence W. Hewlett,
by Charles E. Tullar
His Attorney.

# UNITED STATES PATENT OFFICE

CLARENCE W. HEWLETT, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

## SOUND RECORDING

Application filed December 4, 1929. Serial No. 411,625.

My invention relates to the recording of sound photographically on a moving light-sensitive member. When reproduction is made from photographic sound records such as are in common use, a certain amount of ground noise is heard which to a large extent is known to be the result of the light which enters the photo-electric cell forming a part of the reproducing apparatus being interrupted by dirt and scratches on the film. When the sound being reproduced is relatively loud the ground noise is not noticeable but when the amplitude of the sound waves decreases the ground noise by comparison becomes the more apparent. It is particularly noticeable before the sound starts and after it ceases.

It is the object of my invention to provide an improved sound recording apparatus by means of which a record may be made such that upon reproduction the amount of ground noise heard is reduced to a minimum.

My invention will be better understood from the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

Referring to the drawings, Fig. 1 is a combined circuit diagram and perspective view of apparatus embodying my invention for making a sound record of the variable width type; and Fig. 2 shows portions of a film having a variable width sound record thereon made by the apparatus shown in Fig. 1.

A preferred method of making a sound record of the variable width type is to employ an oscillograph galvanometer connected to a suitable sound pick-up device through one or more thermionic amplifiers and arranged to reflect a light beam on the moving film. The beam reaching the film should be a very narrow line of light extending transversely of the direction of motion of the film. The galvanometer is arranged to cause the light beam to vibrate in a direction also transverse to the direction of motion of the film, the length of the light line which impinges on the film varying in accordance with the vibrations of the beam. Since the current which actuates the galvanometer is alternating in character the reflected light beam swings on both sides of its normal or zero deflection position. With the moving element of the galvanometer at rest the latter heretofore usually has been adjusted to cause the light line on the film to cover approximately one half of the width of the sound track, which is the strip on the film reserved for the sound record, hence in the recording operation the portion of the film exposed by the light line has varied each side of the center line of the sound track.

In Fig. 1 of the drawings I have shown the unexposed film 1 upon which the sound record is to be photographed passing down under the guide roll 2, over the drum 3 and over a second roll 4. In order to simplify the drawings I have purposely omitted showing any means for driving the film as well as the usual magazines, enclosing casings, etc. which constitute parts of the complete apparatus since they form no part of my present invention. At the point of exposure, the film is supported on the surface of the drum and may be moved at that point either by the drum through suitable connections with a driving motor or to be moved by rolls or sprockets connected with the motor.

The optical system by means of which the narrow line of light 6 is focused on the film is shown, for example, as comprising the electric lamp 7 forming the light source, the condensing lens 8, the light stop 9 for producing a sharp working edge on the light beam, the mirror 10 of the oscillograph galvanometer 11 of standard construction, the cylindrical lens 12, the screen 13 having a narrow opening 14 therein, and the microscope objective 15. Elements 12 to 15 inclusive, it will be noted, are mounted for convenience in the tube 16, the objective 15 being adjustable therein to facilitate focusing the light beam on the film. The light beam which passes the vertical edge of the stop 9 is reflected by the mirror 10 into the tube 16 on screen 13 being concentrated in one meridian by the cylindrical lens 12. As the mirror vibrates the reflected beam vibrates in the direction of the opening 14 in screen 13 illuminating more or less of the opening. That part of the opening which at any instant is illuminated is imaged on a reduced scale on the film forming the light line 6. As the film moves uniformly past the focused beam forming the light line the variation in length of the line in accordance with the sound waves exposes the film in a manner to form a sound record of the variable width type, as shown, for example, at the left side of the positive film illustrated by Fig. 2.

In making such a record, as has already been pointed out above, the zero deflection position of the galvanometer heretofore has been adjusted to cause the dividing line between the exposed and the unexposed portion of the sound track to vibrate equally on both sides of the center line of the sound track. Accordingly when no sound is being recorded, substantially one half of the sound track is exposed and the other half is unexposed The unexposed half of the negative and the opposite half of the positive print therefore are clear. It is this portion when the record is being reproduced which gives rise to the objectionable ground noise.

To make a negative sound record with the above described apparatus I cause the opening 14 to be illuminated for its entire length when no sound is being recorded, hence the line of light 6 has a maximum length and the entire sound track on the negative is black after development. When the sound comes on, the galvanometer mirror not only is vibrated in accordance with the sound waves but the zero about which the oscillation takes place is shifted in accordance with the amplitude of the waves. The resulting record as illustrated by Fig. 2 has the wave peaks extending the full width of the sound track but at those times where there is no sound the sound track is entirely black, hence no light enters the photo-electric cell. I shall now describe the apparatus which I have devised for causing the galvanometer to function in this manner.

The circuit 18 carrying the input signal to be recorded is shown connected across the resistance 21 which for example may have a value of ½ megohm. The terminals of this resistance are connected respectively to the grid and filament of the thermionic amplifier 22 biased by the battery 20. The plate circuit of this amplifier is shown fed from the battery 23, which for example may be 450 volts, through the load impedance 24 which for example may be a 30,000 ohms resistance and is connected to the grid of the thermionic amplifier 25 through the condenser 26 which may have a value of 0.1 mf. Amplifier 25 is biased by battery 27 through resistance 28 and has the load impedance 29 which for example may be 4,000 ohms. Reference number 30 represents a rectifier of the thermionic type. Although this rectifier need have but two elements it has been shown on the drawings as a three-element device, the grid of which not being used as such is tied to the plate. It is fed from amplifier 25 through the condenser 31 which may have a value of 2 mf. The rectified current passes through the grid leak 32, for example, of 22,500 ohms, to the filament. A suitable portion of the amplified signal from the amplifier 25 is applied through the condenser 33 which may have a value for example of 0.1 mf. to the grid of the thermionic amplifier 34 which should have a relatively large capacity. If desired the necessary capacity may be obtained by the use of a plurality of smaller amplifiers connected in multiple. The voltage established by the rectified current from the device 30 is applied to the grid of the amplifier 34 to bias the same. This rectified voltage is filtered by the resistance 36 and the condenser 37 which for example may have values respectively of 100,000 ohms and 0.1 mf. so as to produce a substantially uniform biasing voltage whose value depends upon the peak value of the signal waves. Resistance 38, which, for example, may be of 100,000 ohms, serves as a portion of the grid leak of the amplifier 34. The magnitude of the signal received by amplifier 34 from amplifier 25 through the resistance 29 is so chosen that the peak values of these signals are just equal to or are a little less than the bias produced by the operation of the device 30. A small additional bias, shown as the battery 39, is applied to the grid of the amplifier 34 so as to be sure that its grid will not gather any electrons. A resistance 40, having for example a value of 50 ohms, is shown placed in the plate circuit of the amplifier 34 partly to straighten out the characteristic and partly to protect the circuit against short circuits. The conductor loop of the oscillograph galvanometer 11, preferably for greater safety, is arranged in the plate circuit on the ground side of the plate battery 42. The loop is by-passed by the battery 43 and resistance 44 in series so that the steady plate current of the amplifier 34 may be balanced out. Variations in the plate current will divide between the resistance and the galvanometer loop in the usual way.

By referring to Fig. 2 it will be seen that the negative film 1 illustrated therein has a sound record 46 thereon which for convenience is shown as that of a constant note, the height of the peaks of the record waves being substantially equal to the full width of the sound track. It will also be seen that before the sound began and after it ceased the entire sound record track is black, hence substantially no light enters the photo-electric cell when there is no sound and the consequent ground noise is a minimum.

The operation of the apparatus illustrated in Fig. 1 will now be described. When there is no sound being recorded there is no current through the oscillograph galvanometer and the latter is so adjusted that the entire opening 14 in screen 13 is illuminated, hence the light line 6 covers the whole width of the sound track. When the sound comes on, the negative bias on the device 34 increases so that the mean plate current is depressed by an amount equal to or slightly greater than the peak value of the current impulses. The result of this change in the mean value of the plate current which passes through the oscillograph galvanometer is to shift the working edge of the light beam just enough or a little more than enough to accommodate the full swing of the vibrations of the beam. When the sound ceases, the plate current assumes its normal value and the entire opening 14 is again illuminated thereby exposing the entire sound track as before. The interval of time required for the mean plate current to assume its proper value is determined by the coupling condenser 31 and the grid leak resistance 32 and also partly by the resistance 36 and condenser 37. As shown in Fig. 2 with apparatus having resistance and capacity values such as those mentioned a few cycles are required for the signal to reach its full amplitude, this however does not materially effect the sound of the record when reproduced.

It will be noted that the film illustrated in Fig. 2 is a negative and that the apparatus shown in Fig. 1 and described above is for making such a negative. My invention, however, is not limited to apparatus for making a negative sound record of the character illustrated but is equally applicable to apparatus for making a record such that a positive print made therefrom shall be of the character illustrated. If such a print is desired it is necessary only to make certain adjustments to the apparatus, namely to rotate the stop 9 through 180° and to adjust the moving system of the galvanometer so that no part of the opening 14 is illuminated but with the working edge of the light beam at one end of the opening. Then as the mirror vibrates in response to the sound more or less of the opening 14 is covered by the light beam. The negative thus made is the reverse of that shown in Fig. 2 so that a print made herefrom will appear like Fig. 2.

I have chosen the particular embodiment described above as illustrative of my invention and it will be apparent that various modifications may be made without departing from the spirit and scope of my invention which modifications I aim to cover by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. Apparatus for photographically recording sound on a moving light-sensitive member comprising means for directing a beam of light on said member, a thermionic amplifier having its plate circuit connected with said means for controlling said beam, means for varying the grid potential of said amplifier in accordance with the sound waves to be recorded whereby the light is caused to vibrate relative to a predetermined zero, and means for varying said zero in accordance with the peak value of said waves including means for varying the grid bias of said amplifier.

2. Apparatus for photographically recording sound on a moving light-sensitive member comprising a source of light, a galvanometer for reflecting and vibrating a light beam from said source on said member, a thermionic amplifier having its plate circuit connected with said galvanometer, means for varying the grid potential of said amplifier in accordance with the sound waves to be recorded whereby the light beam vibrates with respect to a predetermined zero in response to the sound waves, and means for varying the position of said zero in accordance with the peak value of said waves, said light means including means for applying to the grid of said amplifier a bias responsive to said peak value.

3. Apparatus for photographically recording sound on a moving light-sensitive member comprising a source of light, a galvanometer for reflecting and vibrating a light beam from said source on said member, an input circuit the current in which varies in accordance with the sound waves to be recorded, a thermionic amplifier between said circuit and said galvanometer, and means for producing a displacement of the zero of said galvanometer in accordance with the peak value of the sound waves, said means comprising a thermionic rectifier connected with said circuit for applying to the grid of said amplifier a biasing potential substantially in accordance with the peak values of the amplified waves.

4. Apparatus for photographically recording sound on a moving light-sensitive member comprising a source of light, a galvanometer for reflecting and vibrating a light beam from said source on said member, an input circuit the current in which varies in accordance with the sound waves to be recorded, a thermionic amplifier having its plate conductively connected with said galvanometer and its grid connected with said input circuit, and a thermionic rectifier and filtering device connecting said input circuit and said grid for supplying a biasing potential to said grid.

5. Apparatus for photographically recording sound on a moving film comprising a source of light, a galvanometer arranged to reflect and vibrate a light beam from said source on said film, an input circuit, a thermionic amplifier having its plate connected with said galvanometer and its grid connect-

ed with said input circuit, a thermionic rectifier and filtering device connecting said input circuit and said grid for supplying a biasing potential to said grid, and means connected with said galvanometer for balancing out the plate current of said amplifier when there is no sound.

6. Apparatus for photographically recording sound on a moving film comprising a source of light, a galvanometer arranged to reflect and vibrate a light beam from said source on said film, an input circuit, a thermionic amplifier having the galvanometer arranged in series in its plate discharge circuit and having its grid connected with the input circuit, thermionic rectifying and filtering apparatus connected with said input circuit and arranged to supply said grid a substantially uniform biasing potential depending upon the average peak value of the current in the input circuit.

In witness whereof, I have hereunto set my hand this 3rd day of December, 1929.

CLARENCE W. HEWLETT.

**April 12, 1932.** L. T. ROBINSON **1,854,159**

SOUND RECORDING

Filed June 24, 1929

Fig. 1.

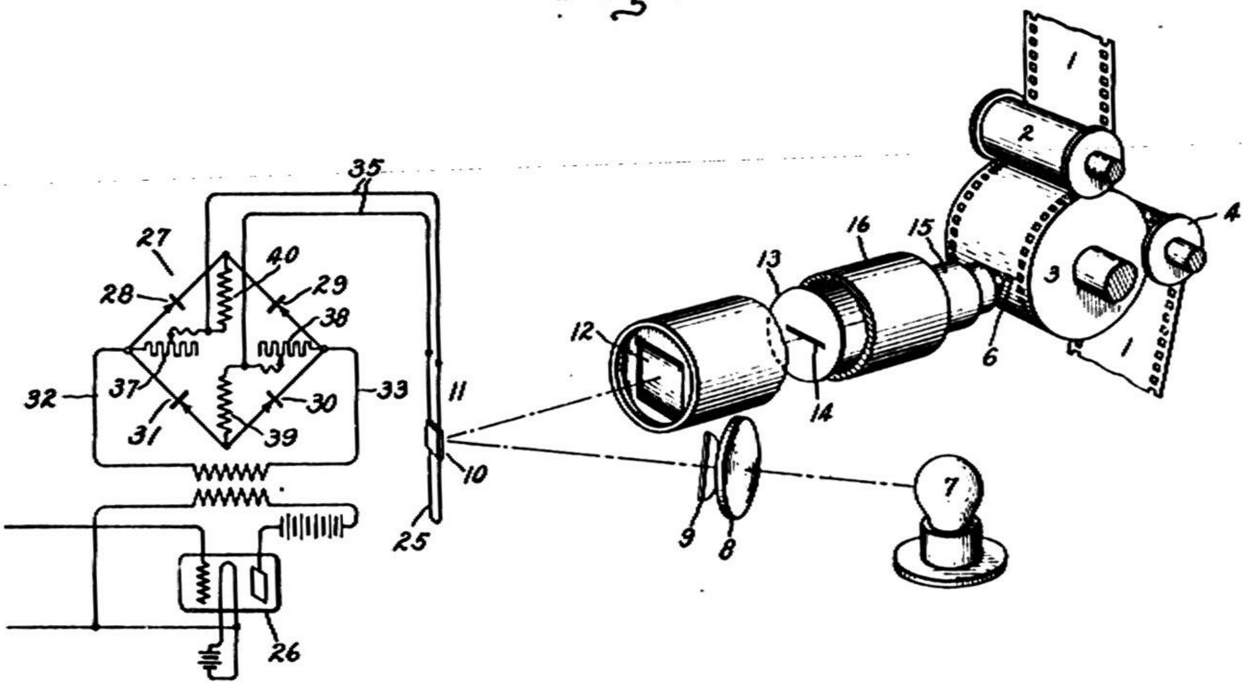


Fig. 2.

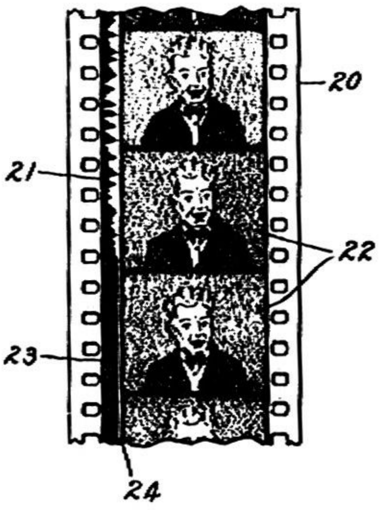
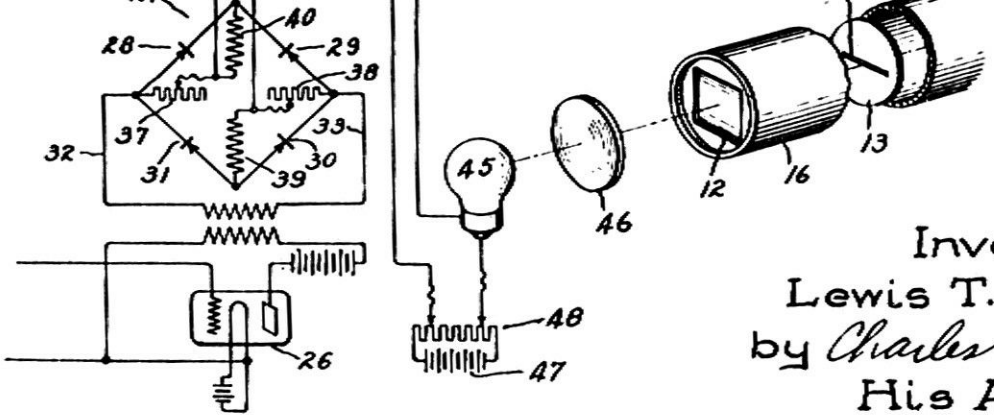


Fig. 3.



Inventor
Lewis T. Robinson,
by Charles E. Tullar
His Attorney.

**Patented Apr. 12, 1932** **1,854,159**

# UNITED STATES PATENT OFFICE

LEWIS T. ROBINSON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

## SOUND RECORDING

Application filed June 24, 1929. Serial No. 373,232.

My invention relates to photographic sound records and to the method and apparatus for making such records. Photographic sound records usually are of one of two types, the variable density type and the variable width type, my invention being applicable to both types.

It is known that a considerable part of the "ground noise" heard when a record of either type is being reproduced is a result of the light passing freely into the photo-electric cell through the relatively clear or thin portions of the sound record. When relatively loud sounds are being reproduced the ground noise is not noticeable but as the amplitude of the sound waves decreases the ground noise by comparison becomes more and more apparent. It is particularly noticeable just before the sound starts and after it ceases.

It is one object of my invention to provide an improved sound record whereby the "ground noise" noticeable at any time during the operation of a reproducing apparatus using such a record is reduced to a negligible amount. Another object of my invention is the provision of an improved sound recording method and apparatus with which a minimum amount of ground noise will be produced when the record is reproduced.

My invention will be better understood from the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

Referring to the drawings, Fig. 1 is a combined circuit diagram and perspective view of apparatus embodying my invention for making a variable width sound record; Fig. 2 shows a portion of a positive motion picture film having at one side a sound record made with the apparatus shown in Fig. 1; and Fig. 3 illustrates apparatus similar to that shown in Fig. 1 for making a variable density sound record.

A preferred method of making a sound record of the variable width type is to employ an oscillograph galvanometer connected to a suitable sound pick-up device through one or more thermionic amplifiers and arranged to reflect a light beam on the moving film. The beam reaching the film should be a very narrow line of light extending transversely of the direction of motion of the film. The galvanometer is arranged to cause the light beam to vibrate in a direction also transverse to the direction of motion of the film, the length of the light line which impinges on the film varying in accordance with the vibrations of the beam. Since the current which actuates the galvanometer is alternating in character the reflected light beam swings on both sides of its normal or zero deflection position. With the moving element of the galvanometer at rest the latter heretofore usually has been adjusted to cause the light line on the film to cover approximately one half of the width of the sound track, which is the strip on the film reserved for the sound record, hence in the recording operation the portion of the film exposed by the light line has varied each side of the center line of the sound track.

In Fig. 1 of the drawings I have shown the unexposed film 1 upon which the sound record is to be photographed passing from a take-off reel, not shown, under guide roll 2, over the drum 3 and over a second roll 4 from which it passes to a take-up reel, not shown. In order to simplify the drawings I have purposely omitted the various sprockets, film driving means, magazines, enclosing casings, etc., which constitute parts of the complete apparatus, as they form no part of my present invention. At the point of exposure, the film is supported on the surface of the drum and may be moved either by the drum through suitable connection with a driving motor or be moved by sprockets connected with the motor.

The optical system by means of which the narrow line of light 6 is focused on the film is shown, for example, as comprising the electric lamp 7 forming the light source, the condensing lens 8, the light stop 9, the mirror 10 of the oscillograph galvanometer 11 of standard construction, the cylindrical lens 12, screen 13 having a narrow opening 14 therein and the microscope objective 15. Elements 12 to 15 inclusive, it will be noted, are mounted for convenience in the tube 16, the objective 15 being adjustable therein to facilitate focusing the light beam on the film. The light beam which passes the vertical edge of the stop 9 is reflected by the mirror 10 into the tube 16 on screen 13 being concentrated in one meridian by the cylindrical lens 12. As the mirror vibrates the reflected beam vibrates in the direction of the opening 14 in screen 13 illuminating more or less of the opening. That part of the opening which at any instant is illuminated is imaged on a reduced scale on the film forming the light line 6. As the film moves uniformly past the focused beam forming the light line the variation in length of the line in accordance with the sound waves exposes the film in a manner to form a sound record of the variable width type, as shown, for example, at the left side of the positive film illustrated by Fig. 2.

In making such a record, as has already been pointed out above, the zero deflection position of the galvanometer heretofore has been adjusted to cause the dividing line between the exposed and the unexposed portion of the sound track to vibrate equally on both sides of the center line of the sound track. Accordingly when no sound is being recorded, substantially one half of the sound track is exposed and the other half is unexposed. The unexposed half of the negative and the opposite half of the positive print therefore are clear. It is this portion when the record is being reproduced which gives rise to the objectionable ground noise. I have found that the clear area of the positve sound record may be reduced to a minimum by adjusting the galvanometer to cause the exposing light beam to take a position scarcely covering any portion of the width of the sound track when no sound is being recorded and by causing the zero position of the galvanometer when it is vibrated in response to the sound, to move toward the center of the sound track. The resulting sound record when printed has a minimum amount of clear area, which area also decreases as the volume of the sound decreases so that when no sound is being recorded the sound track is almost entirely black. In Fig. 2 I have shown a small section of a positive motion picture film 20 having a sound record 21 thereon, in accordance with my invention, arranged between the pictures 22 and one row of sprocket holes. It will be noted that in the lower portion of the film section illustrated, where no sound is recorded, the sound track 23 is all black except the narrow clear band 24.

As seen from Fig. 2 the opaque portion of the sound record has a series of peaks which extend substantially to but not beyond the boundary of the clear portion of the sound track. The axis of the record or line of separation between the opaque and clear portions during the recording of sound is not straight as in the former variable width records but on the contrary is irregular and at varying distances from the straight boundary line of the sound track in accordance with the volume characteristic of the sound being recorded. For example, when there is no sound the axis is parallel with and close to the track boundary of the clear portion; when, however, there is sound the axis recedes from that boundary in accordance with the volume of the sound.

I shall now describe the means which I have devised and illustrated in Fig. 1 for causing the oscillograph galvanometer to vibrate the exposing light beam in the manner described. Connected between the bifilar moving element 25 supporting the mirror 10 of the galvanometer and the last amplifier 26 of which there may be several connected with the pick-up microphone (not shown) is the rectifying apparatus 27. The purpose of this apparatus is to superimpose upon the normal sound responsive current fed to the galvanometer a suitable rectified component thereof. I employ an arrangement comprising four contact rectifiers 28, 29, 30 and 31, such, for example, as those described and claimed in the Grondahl Patent 1,640,335, August 23, 1927, connected in the manner shown by the leads 32 and 33 with the filament and plate circuit of the amplifier 26 and by the leads 35 with the moving element 25 of the galvanometer. These connections include the variable resistances 37 and 38 and the inductances 39 and 40. Preparatory to using this apparatus to make a sound record I prefer first to adjust it by varying the values of resistances 37 and 38 while employing, for example, a 500 cycle steady signal from the amplifier 26 until the half cycle deflection of the light beam due to the alternating signal current is substantially equal to the deflection due to the rectified current. I then adjust the zero deflection position of the galvanometer so that when there is no sound being recorded the light beam laps over a small fraction only of the sound track which in the positive appears as the narrow clear line 24. In some cases I may adjust the galvanometer so that there shall be no overlap of the beam, hence no line 24 when there is no sound, but to avoid unnecessarily cutting off the peaks of high amplitude waves I prefer to have the slight overlap described. The rectifier may be adjusted so that the rectified current equals the normal alternating current sound current, is greater, or is less than the same as conditions require. By reason of the inductance in the circuit of the rectified current the wave form is smoothed out to the desired extent and while I have obtained satisfactory results using the arrangement shown whereby I believe the value of the rectified current which displaces the zero deflection position of the galvanometer corresponds approximately to the average value, I may in certain cases prefer to make use of any of the well known arrangements to make the shifting of the zero responsive to the peak value of the sound current instead of the average value or to even use the R. M. S. value. It will be understood that the circuit constants may be varied at will to suitably delay the time change of the rectified component of the current to give any desired operation of the galvanometer. It will be understood that in any case the frequency of variation of the rectified current should be below the audible range.

In reproducing from sound records as heretofore constructed where the ground noise prior to the beginning of the sound or after the termination thereof has been objectionable the operator sometimes has operated the fader to cut off the light beam directed on the film during the times of silence. With a film made in accordance with my invention the light reaching the cell is almost entirely cut off automatically whenever there is no sound, the quantity of light reaching the cell is also reduced as the volume of the sound is reduced.

In the arrangement which I have shown the exposing light beam has a sharp edge, called the working edge, due to the straight side of stop 9 and the focal position thereof, hence the serrated edge of the sound record 21 is sharply defined. If, however, the sound record is made with a graded edge produced, for example, by using a graded edged stop 9 or by merely placing the stop at the proper out-of-focus position and allowing the wave peaks to over-shoot the limits of the sound track a record is obtained which resembles the variable density or ladder type of record. Here again the ground noise is reduced by the use of the rectifying apparatus already described to shift the zero position of the galvanometer.

For making a record such as shown in Fig. 2, initial setting of the galvanometer resulting in the clear band 24 of the print will depend to a certain extent on the relative value of the rectified current, it being desirable to start with the galvanometer zero spaced from the adjacent edge of the sound track only so far as to insure against the possibility of the peaks of the recorded waves excesively overshooting the limit of the sound track at that edge since it has been found that any material cutting off of the peaks at one edge results in a noticeable distortion of the reproduced sound.

In the form of my invention illustrated in Fig. 3 for making a sound record of the variable intensity type, the film, the supporting drum therefor, and the means for focusing on the film a narrow light line are similar to what is shown in Fig. 1. Instead of employing a light source of constant intensity and reflecting a light beam therefrom by an oscillograph mirror as in that figure there is shown the variable intensity discharge lamp 45 whose rays are condensed by the spherical lens 46 and the cylindrical lens 12 on the screen 13 having the narrow opening 14. The entire opening is constantly illuminated, the degree of illumination being variable in accordance with the sound waves to be recorded. Lamp 45 is illuminated partly by direct current from the battery 47 to which it is connected through the potentiometer device 48 and partly by combined alternating and direct currents from the rectifying apparatus 27. The latter is shown as similar to that illustrated in Fig. 1, the circuit 35 being connected in series with the lamp 45 and the potentiometer 48 so that the rectified current shall assist the battery current. In using this apparatus to record sound, the potentiometer is adjusted so that when there is no sound the illumination of lamp 45 is somewhat below that required for good sound recording, the light being preferably so dim at such times that the film is substantially unexposed. During the recording of sound the rectified current brings up the illumination of the lamp to a proper or intermediate recording intensity such as that which would be used were no rectifier employed. The alternating current corresponding to the sound waves being recorded then modifies the illumination of the lamp causing it to vary above and below said intensity in the well understood manner.

I have chosen the particular embodiments described above as illustrative of my invention and it will be apparent that various modifications may be made without departing from the spirit and scope of my invention which modifications I aim to cover by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. The method of making a photographic sound record adapted to produce a minimum amount of ground noise upon the reproduction of the recorded sound which comprises exposing a sensitive film to a light beam, varying the beam in accordance with the wave form of the sound being recorded and varying the zero of the beam in accordance with the volume of the sound.

2. The method of making a variable width photographic sound record in which the clear area varies with the volume of the sound being recorded which comprises exposing a sensitive film to a light beam, vibrating the beam laterally of the film in accordance with the wave form of the sound being recorded, and producing a lateral displacement of the zero position of the beam in accordance with the volume of the sound.

3. A film having a sound track containing variable width photographic record of sound waves the axis of the record varying in position relative to one side of the sound track in

accordance with the volume characteristic of the recorded sound.

4. A film having a sound track containing a variable width photographic sound record the peaks of the opaque portion of the record extending substantially to the side of the sound track irrespective of variations in the volume of the recorded sound.

5. A film having a sound track containing a sound record which record comprises relatively clear and opaque portions bounded by the respective opposite sides of the sound track, the axis of the record receding from the side of the sound track bounding the clear side of the record in accordance with the volume of the recorded sound.

6. Apparatus for photographically recording sound on a moving sensitive film comprising means for directing on the film a variable light beam, and means for supplying to said means for the control thereof an alternating current corresponding to the sound waves to be recorded and a direct current in response to the sound.

7. Apparatus for photographically recording sound on a moving sensitive film comprising means for directing a variable light beam on the film, and means for supplying to said means an alternating current corresponding with the sound waves to be recorded and a direct current variable in accordance with said sound waves.

8. Apparatus for photographically recording sound on a moving sensitive film comprising means for directing a variable light beam on the film, and means for supplying to said means an alternating current corresponding with the sound waves to be recorded and a superposed rectified component of said current.

9. Apparatus for photographically recording sound on a moving sensitive film comprising means for directing a variable light beam on the film, and means for supplying to said means an alternating current corresponding with the sound waves to be recorded, means for modifying the response of said first mentioned means to said alternating current in accordance with a rectified component of said current.

10. Apparatus for making a variable width photographic sound record in which the area of the clear portion thereof varies approximately with the sound volume including means for directing a light beam on a light sensitive film and means for vibrating the beam laterally in accordance with the sound waves to be recorded and for producing an additional lateral displacement of the beam in accordance with the volume of the sound.

11. Apparatus for photographically recording sound on a moving sensitive film comprising a source of light, means for directing a light beam therefrom on said film and for vibrating the beam transversely of the film in accordance with the sound to be recorded, and sound responsive means for shifting the zero deflection position of said beam transversely of said film.

12. Apparatus for photographically recording sound on a moving sensitive film comprising a source of light, means comprising an oscillograph galvanometer for reflecting a light beam from said source on said film and for vibrating it in accordance with the sound waves to be recorded to form a variable width sound record, and means responsive to said sound waves for shifting laterally of the film to zero deflection position of the vibrated light beam.

13. Apparatus for photographically recording sound on a moving sensitive film comprising a light source, an oscillograph galvanometer arranged to reflect a light beam therefrom to said film and adapted to be vibrated by an alternating current corresponding to the sound to be recorded thereby forming a variable width sound record, and means responsive to said sound for superposing a direct current on the alternating current input of said galvanometer.

14. Apparatus for photographically recording sound on a moving sensitive film comprising a light source, an oscillograph galvanometer arranged to reflect a light beam therefrom to said film to form a variable width sound record thereon, and means for supplying to said galvanometer an alternating current corresponding to the sound waves to be recorded, and a superposed rectified component thereof.

15. Apparatus for photographically recording sound on a moving sensitive film comprising a light source, an oscillograph galvanometer arranged to reflect a light beam therefrom to said film to form a variable width sound record thereon, a sound current amplifier having a connection with said galvanometer, and rectifier means in said connection for superposing on the alternating sound responsive current supplied to the galvanometer a direct current controlled in value by the sound being recorded.

In witness whereof, I have hereunto set my hand this 22nd day of June, 1929.

LEWIS T. ROBINSON.

# DISCLAIMER

1,854,159.—*Lewis T. Robinson*, Schenectady, N. Y. Sound Recording. Patent dated April 12, 1932. Disclaimer filed August 13, 1938, by the assignee, *General Electric Company*.

Hereby enters this disclaimer to claims 1, 6, 7, 8, and 9 of the said Letters Patent.
[*Official Gazette September 6, 1938.*]

Nov. 22, 1932. C. R. HANNA 1,888,724

# SOUND RECORDING AND REPRODUCING SYSTEM

Filed Nov. 23, 1928

Fig. 1.

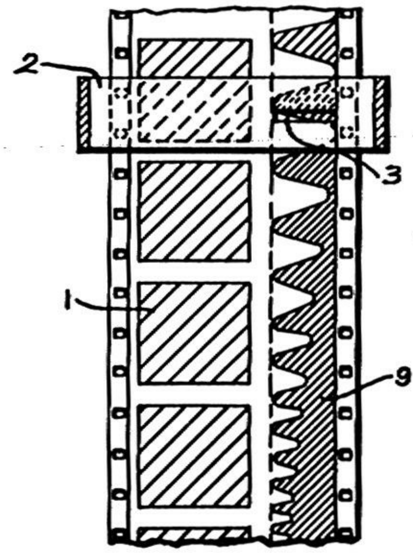


Fig. 2.

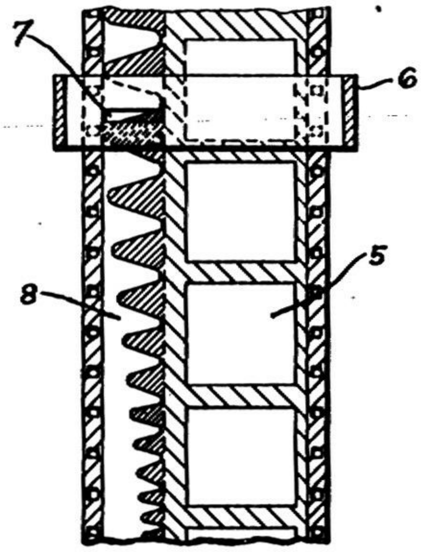


Fig. 3.

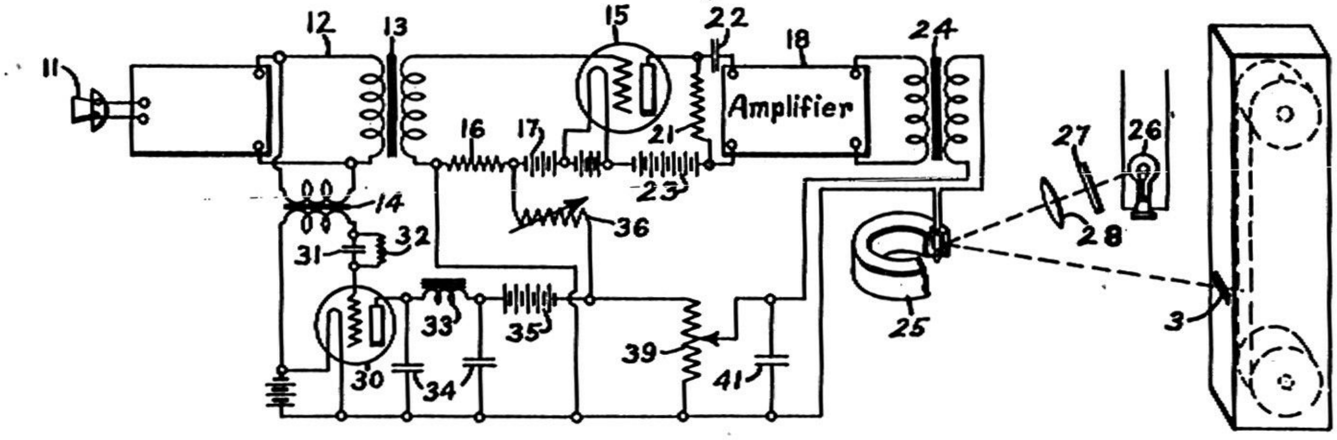
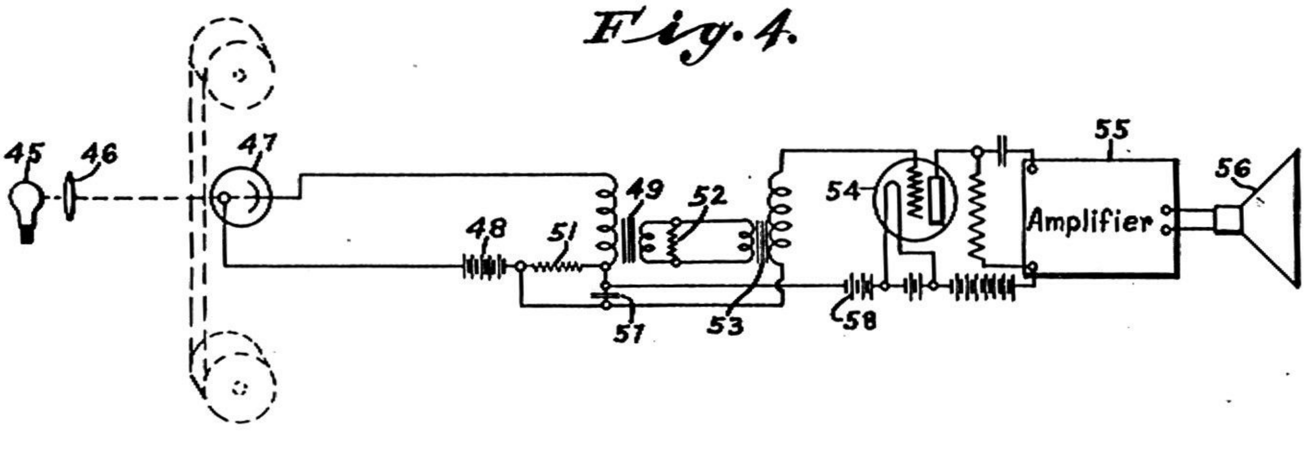


Fig. 4.



INVENTOR
Clinton R. Hanna

BY Wesley G. Carr
ATTORNEY

Patented Nov. 22, 1932 1,888,724

# UNITED STATES PATENT OFFICE

CLINTON R. HANNA, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

## SOUND RECORDING AND REPRODUCING SYSTEM

Application filed November 23, 1928. Serial No. 321,365.

The invention relates to methods of and means for recording and reproducing sound and particularly to photographic methods and means for this purpose in which the intensity of the sound is represented by variations in the amount of light delivered to the record.

All sound-recording-and-reproducing devices introduce more or less extraneous noises, including ground tones. When the sound to be recorded is fainter than that to which the apparatus is ordinarily adjusted, as, for example, when it is a diminuendo passage in music, the distinction between the sound and the ground tone is less, and the satisfactory recording and reproduction of such sounds is thereby rendered difficult.

It is an object of my invention to provide a means for satisfactorily recording and reproducing sounds, even when the program includes both loud sounds and faint sounds.

It is a further object of my invention to provide a variable degree of amplification between the sound-responsive device and the recording instrument, whereby a greater degree of amplification may be utilized for faint sounds.

It is a further object of my invention to provide a feature in the record by means of which the degree of amplification utilized in reproduction may be so controlled that sounds which were recorded with a high degree of amplification may be reproduced with a small degree of amplification.

It is a further object of my invention to provide automatic means whereby the degree of amplification between the microphone and the recorder may be made to correspond to the average intensity of the sound and also automatic means whereby the degree of amplification between the record-controlled device and the sound-producing device may be automatically adjusted in accordance with the above-mentioned feature of the record.

It is a further object of my invention to provide means whereby the average degree of darkening of the negative may be controlled in accordance with the average intensity of the sound. The excess or deficiency of darkening, at any point of the record, corresponding to the momentary sound pressure, will, in the case of the area type of record, be manifest as peaks or valleys at one edge of the darkened area.

In the case of a photographic record of the type in which not area but density varies with the sound, the momentary changes corresponding to instantaneous sound values will be manifest as bands or lines across the record, denser or thinner than the average. In a negative of this type, the average density changes as the average width of the darkened area changes in the record of the first-described type.

Changes in the degree of darkening, whether they are changes of density or of area of the darkened portion, can represent the sound values, and the average darkening can represent the average intensity of the sound in either type of record.

Obviously, both the average character and the variations from point to point in the negative are represented by corresponding opposite characteristics in the positive. Where the average darkening of the negative is greatest, the positive will show a greater average degree of clearness. In the case of the area-type of record, this means that the clear area in the positive will be greater at such places. In the case of the variable-density type of record, this means that the positive will, on the average, be more transparent there.

It is a further object of my invention to so correlate the change in average darkening with the change in amplification that the individual maxima of darkening will be of a more nearly constant value.

It is a further object of my invention to provide a means whereby the average value of the rectified current from a microphone may be indicated by a bias upon the grid of the first amplifier tube.

It is a further object of my invention to provide means whereby the average degree of illumination of a photo-electric cell shall control the average potential of the grid of a vacuum tube.

My invention will be better understood by reference to the following detailed description and the accompanying drawing, in which:

Figure 1 is a view, partially in section and partially diagrammatic, of a portion of the negative of a photographic sound record.

Fig. 2 is a similar view of a positive corresponding to the negative in Fig. 1.

Fig. 3 is a diagram of the circuits and apparatus used in the recording system, and

Fig. 4 is a diagram of the circuits and apparatus used in the reproducing system.

In the negative shown in Fig. 1, the frames 1 represent the pictures of an ordinary moving picture record. The rectangle 2 represents the guide through which the record must pass while recording sound. The window 3, which is shown in Fig. 3, also represents a slit through which the record is illuminated to a greater or less extent, corresponding to the sound.

The positive record shown in Fig. 2 comprises corresponding parts, including the rectangular pictures 5. A gate 6 and a window 7 cooperate with the sound record 8. The sound record 8, represented by the clear area in Fig. 2, corresponds to the darkened area in the negative represented by the shaded area 9 in Fig. 1.

In the apparatus shown in Fig. 3, a microphone 11 supplies current in the output circuit 12 which includes the primary of a transformer 13 and the primary of a transformer 14 in parallel thereto.

The secondary of the transformer 13 is connected to the grid of a vacuum tube 15 and, through a resistor 16 and a biasing battery 17, to the filament of the same tube. The tube 15 is connected to an amplifier 18, the connection being of a character which causes the tube 15 to amplify to a degree determined by the average potential upon its grid. One well-known circuit for producing this result is illustrated. It includes a resistor 21 in the plate circuit of the tube 15 and a condenser 22 by means of which the end of said resistor nearest the anode of the tube is connected to the input of the amplifier 18.

The usual plate battery 23 is inserted, at any desired point, in the plate circuit. If placed, as shown, at the filament end of the resistor 21, the same plate battery may also serve as the B-battery for the amplifier 18.

The output of the amplifier 18 is connected, preferably through a transformer 24, to the vibrating element of an oscillograph 25. A light source 26, with which are associated a diaphragm 27 and an optical system, represented by the lens 28, illuminates the mirror of the oscillograph. The light reflected from the mirror is received upon the slit 3 and illuminates more or less of the film, according to the position of the mirror. The diaphragm 27 is preferably made to present a sharp straight edge to the light in order that the edge of the sound record made upon the film shall be definite.

The transformer 14 supplies the input of a vacuum tube 30 which is equipped with a grid condenser 31 and grid leak 32, causing the tube 30 to act as a rectifier. A low-pass filter is inserted in the plate circuit of the tube 30. This filter includes an inductor 33 and a pair of condensers 34. The B-battery 35 is shown as outside of this filter but it may be inserted at any convenient point in the plate circuit.

The resistor 16 is connected across the plate circuit of the tube 30 outside of the filter. If desired, an adjustable resistor 36 may be included in the shunt connection. The resistor 39 of a potentiometer is connected in parallel to the resistors 16 and 36. Between the slider of the potentiometer and one end thereof, a condenser 41 is connected. The output circuit of the potentiometer is connected to the secondary of the transformer 24 in series with the oscillograph 25. The condenser 41, the transformer secondary and the vibrator of the oscillograph thus form a circuit which, preferably, is of small impedance to currents of audio frequency.

In Fig. 4, the light source 45 is concentrated by any suitable optical system, represented by the lens 46, upon a sound record which is made by printing a positive, like that shown in Fig. 2, from a negative, like that shown in Fig. 1. The light which traverses the sound record is received in a photo-cell 47 which is supplied with current from a battery 48. The circuit of the battery 48 includes the primary of a transformer 49, a resistor 51 and the photo-cell 47 in series.

A resistor 52 is connected across the secondary of the transformer 49 in a loop circuit which includes the primary of a transformer 53, through which the link circuit is connected to the grid circuit of a vacuum tube 54, connected to an amplifier 55, preferably in the same way as the tube 15 to its amplifier 18. The output of the amplifier 55 supplies a loud speaker 56 or other sound-reproducing device.

In shunt to the resistor 51 is a condenser 57 which is connected to the grid and filament of the tube 54. A C-battery 58 is included in the connection to provide a bias upon the grid of the tube 54.

In the operation of the device, the sound to be recorded is received upon the microphone 11. Currents produced thereby in the circuit 12 are transmitted by the transformer 13 to the grid and filament of the tube 15 and amplified thereby to a degree determined by the average potential upon the grid 15.

Currents in the circuit 12 produce varying potentials upon the grid of the rectifier tube 30. Because of the condenser 31 and the resistor 32, the changing potentials cause a charge to accumulate upon the grid of the tube 30 and thus vary its potential in a way which corresponds to the average value of the amplitude of the changing potentials.

This action is well understood, being strictly analogous to the action of the usual grid-condenser—grid-leak type of detector. The difference, however, is that the oscillations in the potential are much slower than in the usual detector tube because the input from the circuit 12 is of audio frequency.

The detector or rectifier tube 30 delivers a current to its output circuit which has a very small audio-frequency component and the main compound of which varies in accordance with the average intensity of the sound at the microphone 11. In order that momentary abrupt changes of intensity or the instantaneous changes, corresponding to the sound pressure, shall not produce corresponding abrupt current changes in the output of the tube 30, the filter 33—34 is provided. Preferably, this filter is of a low-pass type, greatly attenuating audio frequencies.

Frequencies of the order of one or two cycles per second, or even as low as a cycle in one or two seconds are transmitted by the filter and produce corresponding changes in the current in the resistors 16 and 39. The correct division of the current between these two resistors may be adjusted by adjusting the resistor 36. A further adjustment of the relation between the effect, at the oscillograph, of the steady or slowly-changing current through the resistor 16 and of the potential changes at audio-frequency transmitted by the transformer 13 is obtained by adjustment of the potentiometer 39.

When the current through the resistors 16 and 36 increases, the potential drop across the resistor 16 increases. The left-hand end of the resistor 16, therefore, becomes more negative, the impedance of the tube 15 increases, the proportion of all the impedance in the circuit of the battery 23 to the impedance of the resistor 21, therefore, increases, and the potential changes delivered across the condenser 22 are, therefore, of smaller amplitude.

It will thus be seen that a change in the average potential across the resistor 16 results in a change in the average amplification performed in the tube 15. If this change, as the apparatus is first set up, is in the opposite direction to that desired, a reversal of the connections from the tube 30 to the ends of the resistor 16 will reverse the direction of change in the degree of amplification.

Faint sounds produce small changes upon the grid of the tube 30, causing only a small negative charge to accumulate thereon and so diminish the current in the plate circuit of the tube 30 only slightly from the value thereof corresponding to silence. Loud sounds produce large changes of potential upon the grid 30 and, consequently, diminish the current through the resistor 16 by a large amount. Therefore, faint sounds result in a high degree of amplification, and loud sounds are amplified to a smaller degree.

The peaks in the record 8, corresponding to faint sound, are shown in the lower part of Fig. 2 as of small height, but they are of relatively greater height than would be the case if it were not for the change in amplification just described.

Similarly, at the top of Fig. 2, the peaks are shown as of greater height, to represent the louder sounds, but they are not of as great a relative height as they would be if the amplification corresponding to loud sounds were not diminished as explained.

In addition to the change in amplification, there is a change in the zero point from which the waves in the record begin. This is accomplished by the steady current through the output of the potentiometer 39. The potentiometer delivers a steady current through the oscillograph 25 which is superposed upon the audio-frequency current introduced through the transformer 24. The effect of the steady current through the oscillograph is to permanently deflect the mirror and thus bring at least a portion of the slit 3 into the region of permanent illumination, or if the permanent deflection be in the opposite direction, a region of permanent darkness. I have called this shift of the base line permanent in order to distinguish it from the changes taking place at audio frequency. Actually, it may change every few seconds or even a few times per second.

The combined effect of the steady and the audio-frequency currents is preferably sufficient to cause the maximum which the length of the illuminated portion of the slit 3 attains during each swing of the mirror to be substantially a constant. Obviously, this ideal is not reached in actual practice, because, in addition to the change in amplitude during a crescendo or diminuendo passage, there are, in any program, momentary louder sounds and moments of silence which are not removed by the slow correcting action of the tube 30.

It is not desirable that they should be removed. The reproduction ought to give these effects with the others. The straight line along the top of the dark peaks in Fig. 1, or the top of the light-colored peaks in Fig. 2, represents this characteristic of the record of a sound of gradually changing intensity, unaccompanied by any sudden changes to louder or fainter sounds.

The film, having been exposed in the apparatus shown in Fig. 3, is developed and printed, thus producing a record like that shown in Fig. 2. Such record is then used in an apparatus like that shown in Fig. 4.

When a portion of the record film corresponding to loud sounds, for example, that in the upper part of Fig. 2 is passing in front of the optical system 46, the photo-cell 47 is illuminated only by the passage of the peaks in front of the slit. There is no area unbroken by valleys passing before the slit. Therefore, the cell is only moderately illuminated.

The average current through the circuit of the battery 48 is, therefore, small, the potential across the resistor 51 is small and the grid of the tube 54 is, therefore, less negative than under average conditions. When the grid is less negative, the amplification is greater. Therefore, the sounds which are recorded with a relatively small amplification when exposing the film are reproduced with a relatively large amplification.

The sound record represented near the bottom of Fig. 2, which corresponds to the record of faint sounds, presents a relatively wide band of clear film. It, therefore, causes the photo-cell 47 to be illuminated strongly. This results in a more negative grid at the tube 54 and, therefore, a smaller degree of amplification. Thus, the sounds which were recorded with a large degree of amplification are reproduced with a small degree of amplification. For this reason, the sounds are not over-emphasized in the reproduced program but appear as faint sounds.

It will be seen that the effect of ground tone, whether due to film noises or to noises in the amplifiers, is largely avoided by this procedure. Loud sounds may be recorded upon the film, without difficulty from ground tone because the latter is negligible, as compared with them. Faint sounds, having been amplified to a greater degree, are then large, as compared with the ground tone. The record ground tone will, therefore, not interfere with the reproduction of the amplified sounds. When reproducing from the record, a high degree of amplification is not employed, even for the faint sounds, and, therefore, any danger of magnifying the ground tone, even when reproducing faint sounds, is avoided.

The means described for impressing a slowly changing potential upon the grid of the tube 15 in the recording device or upon the grid of the tube 54 in the reproducing device are automatic. Obviously manual adjustments guided either by ammeter readings or by the operator's estimate of the average loudness may be made to give the same results.

By reversing the connections from the grid and filament to the resistor either at the tube 15 or the tube 54, the negative, instead of the positive, may be used for reproduction.

The system, with the connections then reversed and the oscillograph adjusted for the zero current position near the sprocket-holes instead of near the picture-record, as shown in Figure 1, will produce a negative in which the crests near the edge of the film will follow approximately a straight line. The shift of the mid-point of the successive undulations with changing amplification, being in the opposite sense when the connections to resistor 39 are reversed, the average degree of darkening of the negative, as a whole, now decreases instead of increasing with faint sounds.

I have shown and described only one form of my invention and mentioned only a few modifications. It will, however, be apparent to those skilled in the art that many other modifications are possible. Accordingly, the omission of specific mention of such modifications is not to be regarded as a limitation. No limitations are intended except those stated in the claims or required by the prior art.

I claim as my invention:

1. In a sound-recording system, an amplifier, including a vacuum tube, means for impressing a potential varying at sound frequency upon the grid thereof, means controlled by the intensity of the sound for impressing a slowly varying potential upon said grid, a recorder including a member moved by the output of said amplifier and means responsive to the said slowly varying potential for controlling the mean position of said member.

2. In a system for reproducing sound from a photographic sound record, a photo-cell the illumination of which is controlled by said record, a circuit in which the current is controlled by said photo-cell, a vacuum tube, means for impressing potential corresponding to the sound-frequency variations of current in said circuit upon the grid of said vacuum tube, and means for impressing a biasing potential upon said grid which varies in accordance with the variation in the average illumination of said photo-cell.

3. A photographic sound record having variations in darkening corresponding to audio-frequency, the amplitude of said variations bearing a ratio to the amplitude of the corresponding sound, which ratio is different at different parts of the record, and the average amount of darkening corresponding to said ratio at each part of the record, whereby the average degree of darkening is correlated to the average intensity of the corresponding sound.

4. The method of reproducing a sound program which consists in translating the sound into electrical pulses, amplifying said pulses to produce amplified current pulses and superimposing said current pulses on a relatively steady current, controlling the degree of amplification of said pulses to cause a greater degree of amplification for faint sounds than for loud sounds, so modifying the amplitude of said relatively steady current that the sum of said steady current and the maximum

value of said current pulses is an approximately constant value, forming a single record of the variable area type in accordance with said sum, controlling an energy output in accordance with said record, amplifying the variations in said output corresponding to said impulses, controlling the degree of amplification in accordance with the amplitude of said relatively steady current as recorded on said record to cause a smaller degree of amplification for faint sounds than for loud sounds, and translating said amplified energy variations into sound.

5. The method of producing a sound record which consists in translating the sound into electrical impulses, amplifying said impulses to produce amplified current pulses and superimposing said current pulses on a relatively steady current, controlling the degree of amplification of said pulses to cause a greater degree of amplification for faint sounds than for loud sounds, so modifying the amplitude of said relatively steady current that the sum of said steady current and the maximum value of said current pulses is an approximately constant value, and forming a record of the variable area type in accordance with said sum.

6. A translating system comprising means for impressing the record of a physical phenomenon on a permanent medium, said record being of the type in which the darkened area of the negative accords with the instantaneous values of said phenomenon and in which the area has peaks corresponding to the intensity of said phenomenon, and means responsive to said phenomenon for so varying the mean position of that boundary line of the record which is defined by said peaks that the tops of said peaks attain substantially a common level.

7. In translating apparatus of the type incorporating means for transforming a mechanical disturbance into an electrical disturbance and means for impressing a record of said electrical disturbance on a permanent medium, said electrical disturbance being microscopic in character, said record being of the type in which the darkened area in the negative accords with the instantaneous value of said electrical disturbance and in which said area has peaks corresponding to the intensity of said electrical disturbance, means for introducing a microscopic variation in said electrical disturbance, said electrical disturbance and said microscopic variation being so related that the tops of said peaks are at substantially a constant level.

8. Sound-recording apparatus comprising means for transforming sound energy into electrical energy, means for varying the amplitude of the electrical energy of said transformed sound, means for impressing a recording of said electrical energy on a permanent medium, said record being of the type in which the darkened area of the negative accords with the instantaneous values of said electrical energy and in which the area has peaks corresponding to the amplitude of said electrical energy, and means responsive to said amplitude for varying the mean position of that boundary line of the record which is defined by said peaks.

9. Sound-recording apparatus comprising means for transforming sound energy into electrical energy, means for impressing a record of said electrical energy on a permanent medium, and means for varying the zero boundary of said record in accordance with the amplitude of said impressed sound energy.

10. A photographic sound record in which the negative has variations in darkening corresponding to audio-frequency, the amplitude of said variations bearing a ratio to the amplitude of the corresponding sound, said ratio being larger for small sound amplitudes than for large sound amplitudes, and the average amount of darkening increasing with the increase in said ratio.

11. Apparatus for reproducing sound from a positive corresponding to the negative described in claim 10 comprising a photo-cell, an amplifier, means for passing light through said positive onto said photo-cell, and means for decreasing the amplifying ability of said amplifier in response to an increase of the average amount of light falling on said photo-cell.

12. A sound record of the variable density type comprising regions of darkness interspaced with background regions of lesser darkness characterized by that the average intensity of the background regions varies in accordance with the intensity of the sound recorded.

In testimony whereof, I have hereunto subscribed my name this 14th day of November 1928.

CLINTON R. HANNA.

90 *Plaintiffs' Evidence*

Filed March 23, 1939

* * *

Washington, D. C.,
Thursday, January 12, 1939.

*Testimony of Arnold Poulsen.*

(Opening Statements of Attorneys for Plaintiffs and Defendant omitted persuant to stipulation filed March 28, 1939).

* * *

**Arnold Poulsen**, one of the Plaintiffs herein, was called as a witness in his own behalf, and having been first duly sworn, was examined and testified as follows:

Direct Examination

By Mr. Kolisch:

Q. Mr. Poulsen, you are one of the joint inventors whose application is involved in this interference, are you not? A. Yes.

Q. And you reside in Copenhagen, Denmark, do you not? A. Yes.

91 Q. Will you please state what qualifications you have by education and experience to testify as an expert in this case, in addition to your qualifications as an inventor? A. I graduated from Denmark's Technical High School in Copenhagen, or as you will probably call it over here, the Danish Institute of Technology in Copenhagen, in 1912.

From 1912 to 1920 I was practicing as an engineer in the fields of telephony, cable telegraphy, and radio.

In 1918 I started, together with my co-inventor, Mr. Petersen, experiments on talking films.

And in 1923 we had found a solution, which was commercially sufficiently good to be exploited.

In 1918 a company was formed for the exploitation of our patents. And after 1923 this company entered into several agreements with various companies in Europe for the exploitation of the inventions.

Since 1923 I have been a director of the Danish company, and since 1928 I have been a director of British Acoustic Films, Limited, which is a subsidiary, a manufacturing subsidiary, of the Gaumont British Corporation in England.

All of that time since I started the experiments in 1918 I have been conducting continued research on problems in connection with talking films.

Also, since 1920 I have been consulting engineer in radio questions to the Danish Government, particularly in connection with marine radio.

92 I have also on many occasions been acting as a court expert, an expert appointed by the court in connection with patent cases in Denmark. In Denmark the court appoints experts in patent cases. These patent cases have been related to amplifiers, radio tubes, radio, and similar arts.

I think that is my whole experience.

Q. Will you please explain, with the aid of Exhibits 1 and 3, how a variable area sound record is made on a motion picture film? A. If your Honor will again look at Exhibit 1, on the right hand side of Exhibit 1, an optical system is shown for the production of a sound record on a film.

The film is shown at the right hand side.

The pictures are shown as shaded rectabgles, and to the left of the pictures is shown a sound track inside one row of the perforations.

This sound track is produced by a transversal strip of light, which is shown underlined in red.

This line of light is formed in the following way: From a lamp shown below the light is concentrated by means of a condenser lens onto a mirror shown to the left. In the way of the rays a rectangular mask is inserted, so that only a rectangular light bundle is concentrated on the mirror. The mirror reflects the light bundle onto a vertical screen, which is provided with a slit, and the light intercepted by that slit is again concentrated by means 93 of an objective lens onto the film, and is forming that narrow strip of light which I mentioned first.

Now in sound recording the mirror is oscillated. That is done, for instance, by means of what we call an oscillograph loop, which consists of two wires, a loop of two wires placed in a magnetic field.

When these two wires are passed by an alternating current corresponding to the sound, they will oscillate in the magnetic field, and thereby cause the mirror to oscillate.

When the mirror is oscillating in this way in a horizontal plane, the reflected light bundle will also oscillate in a horizontal plane, and thereby the shaded cross-section of the light bundle will oscillate over the slit, thereby shortening or lengthening the line of light which is projected on the film.

Q. Pardon me for interrupting, Mr. Poulsen, but I assume that you mean that portion of the line of light which falls on the sound track? A. Yes. We are only interested in that part of the light line which is falling on the sound track. The rest of the light line will be cut off by some mask. Thereby one end of the light line will describe the wavy line shown the film.

94 We have shown the sound track as black, so that the area which is exposed by the light line appears as white area.

In fact, if you expose a sound film and develop it, that part which is exposed by the light will become black. But then again a positive is made and too the black part will be white, and of course the white part will be white, so we have preferred to show the sound track as it appears in the positive.

Now, if your Honor will look at Exhibit 3, Fig. A, Fig. A is just showing a sound track as it was normally made before the invention which we are claiming in this case was made.

We have here shown the simple case of a sinusoidal current, the amplitude of which first increases up to a maximum, and then decreases. That is a simplified example of a sound.

It will be seen that we start in the middle of the sound track. A line of light was in those days always so adjusted that the end of the light line was in the middle of the sound track, so that when there would be no sound half of the track would be exposed and the other half would be unexposed, and therefore after development half of the track would be black and the other half would be transparent.

Q. Mr. Poulsen, I assume by "those days" you mean the early days of talking movies in the 20's? A. Yes,
95 before silent recording was introduced.

Now, this type of track produced a rather harmful, a rather disturbing background noise because the transparent parts of the track would not be totally transparent, as they should be. There would be small spots of silver caused by development. There would be small parts of dust collected during the drying process, and so on, small scratches perhaps, and all these small impurities in the transparent part would be reproduced as sounds.

In reproduction a light line is passed beyond that, and therefore the light which is passing the film will vary in accordance with the sound track and the amplitude of sound. But it will also vary if some small spots of dust or silver are entering the light beam or the light line. And as these spots are very numerous and the speed of the film is great, they will create a hissing noise exactly analogous to the hissing noise in the reproduction of gramophone records that is due to the scratching of the needle, the needle vibrating according to small mechanical imperfections. Here it is due to small optical imperfections in the sound record.

Now, this background noise was rather disturbing, not so much when there was a sound recorded at the same time, but in the intervals between the sounds it was heard as a hissing noise.

96 It will be noticed by looking on Fig. A that in the average the transparent area is the same all the time. I say the average because even at large amplitudes half of the time the film is transparent and half of the time it will be opaque. So on an average there will be the same transparent area all of the time, and you will have a constant hissing noise, but you will not have a hissing noise when you have loud sounds, whereas if you have no sounds or weak sounds, you will hear it.

Now, this was a rather serious problem, and many inventors were working for the overcoming of it.

In Fig. C on Exhibit 3 it is shown how two outstanding inventors, Robinson and Hewlett, of the General Electric Company, overcame the difficulty. Instead of adjusting the light line so that the end of it was in the middle of the

sound track, they adjusted it so that it was at the edge of the track when there was no sound. And when the sound came in they moved the zero line, which is the middle point between maximum and minimum, towards the other side of the sound track. And they moved it in accordance with the volume of sound, so that there would always be space enough for the sound to be recorded. Therefore, in Fig. C
all the lower points of the record are situated on a
97 straight line parallel to the edge of the track.

In this record, contrary to the record shown in Fig. A, the transparent area is nearly zero when there is no sound, and the transparent area only increases in accordance with the value of the sound amplitude, so that there will be an approximately constant relation between the sound volume and the volume of the background noise, and therefore you will hardly notice it.

Q. Now, before you leave that subject, will you explain, by means of Exhibit 1 preferably, just how Robinson and Hewlett accomplished this? I want you to discuss it now in general terms, and later on we will take it up specifically when we discuss the patents. A. Yes. In the left hand side of Exhibit 1 the electrical part of the circuit used in sound recording is shown schematically.

At the terminals to the left the sound responsive alternating current is introduced. It may be produced by a microphone in the usual way. This current is amplified by means of an amplifier, and passed on to the oscillograph loop, thereby causing the oscillograph loop to oscillate, as I described before.

This arrangement—if your Honor for a moment will ignore the lower part of the circuit—would produce a record
as shown in Fig. A of Exhibit 3.

98 Q. Fig. A of Exhibit 3? A. Fig. A of Exhibit 3.

Now, what Robinson and Hewlett did was to branch off part of the alternating current and rectify it by means of a rectifier, as shown in the lower part of the diagram.

This rectified current, which is a direct current, a d. c. current, as we used to say it, was also passed on to the oscillograph.

This direct current will cause the mean position of the oscillograph to moge, so that if the oscillograph is so adjusted, as I described before, that the edge of the light line is close to one edge of the sound track, it will be moved towards the other side in accordance with the value of the rectified current.

Now, this rectified current, as it is rectified from the alternating current, will always be in accordance with the volume of the sound. If you have a weak sound it will be small, and if you have a more powerful sound it will be greater. So the end of the light line, or the recording edge of the light line will be removed, or I should say the average position of the recording edge of the light line will be removed towards the other side of the sound track. We may express that by saying that a variable bias was produced on the zero line.

99 The Court: What does he mean, the base?

Mr. Kolisch: Bias.

The Witness: Bias (spelling).

The Court: Bias?

Mr. Kolisch: Yes.

By Mr. Kolisch:

Q. And this variable bias, as I understand it, will produce the following results: whereas normally the mirror will try to oscillate about one point in accordance with the originally recorded sound, and that one point remained fixed, corresponding to the center line of the track, the Robinson and Hewlett patents still oscillate the mirror in accordance with the sound, but as the amplitude of the sound varies they move this pivot point by means of this bias current to the left or to the right, is that right? A. That is so.

Q. And as I understand it, one limit, and the only line to this displacement of the pivot point of the mirror was the lower edge of the track? A. Yes.

Q. And no limit was placed to the displacement of that bias or to the displacement of the pivot point or to the displacement of the zero line, all of which comes to the same thing, in the other direction, is that right? A. Yes.

100 Q. They always varied it and kept on moving it as the loudness of the sound increased, is that right? A. Yes.

Q. Now, will you again refer to Exhibit 3 and compare the normal sound track in Fig. A with the Robinson and

Hewett sound track in Fig. C, and point out to the court, please, what happens to the peak of the exceptionally loud sound? A. In sound recording one is always trying to keep the maximum peak of the recorded sound inside the border of the sound track in order to avoid distortion, because if it is going beyond it will be masked off either in recording or in reproduction or both, so what is outside is not only not recorded, but on account of the sudden cut-off, the sharp cut-off, distortion will be introduced. Technically, it is expressed by saying that harmonics are introduced. Like in radio, if you overload a radio tube you cut off the maximum peaks and the sound is distorted.

Now, whereas one will always try to avoid such cut-off, it is not in practice always possible to avoid it because the volume of sound may suddenly and unexpectedly go up. For instance, if an actor is shouting, or if you have a shot of a gun, or something like that.

In normal sound recording this did not produce a very harmful distortion because if the zero line was in the middle of the track the cut-off would be symmetrical, the
101 sounds would be cut equally off on both sides of the
sound track, and thereby some of the harmonics which are introduced are entirely eliminated. But in the noiseless recording invented by Robinson and Hewlett, as shown in Fig. D, the cut-off will not by symmetrical. It will be asymmetrical. Only the peaks on one side will be cut off, and will be cut off double as much as they would be cut off in the normal recording, assuming that the overshooting is the same in both cases.

Now, this asymmetrical cut-off is causing a very harmful distortion which can be heard. So at the same time as this reduction of the background noise was obtained a rather harmful effect of distortion was introduced.

Q. Could the average audience in a motion picture house discover or notice this distortion? A. Oh, yes.

Q. Could you describe the nature of the distortion more specifically? A. As I said before, by the cutting off harmonics or overtones are introduced.

If you take the example of a pure sinusoidal sound wave which is reproruced as a pure note, say at the frequency of 1,000 cycles per second, then in the case of Fig. A the first harmonic produced would be 3,000, the next would be

5,000 cycles per second, and so on, because all the even
harmonics, the second and the fourth and sixth would
102 be eliminated. Whereas, in Fig. C already the sec-
ond harmonic would be introduced, the second, third,
fourth, fifth, sixth, and so on, and all the whole series of harmonics. The first harmonic would be of the frequency of 2,000, the next 3,000, the next 4,000, and so on, and these lower harmonics are much more audible to the ear. The hearing sense decreases with increasing frequency. So the lower the harmonics, the more harmful they are to the hearing.

Q. And that would produce an entirely strange noice to the hearing? A. Yes. It is as if you introduced a noise which has nothing to do with the original sound, an additional noise.

Q. Now, without going into detail, will you now, preferably with the aid of Fig. B, Exhibit 3, discuss the solution that Hanna patented and discuss this problem of silent recording? A. By means of Fig. B?

Q. Fig. B, yes, Exhibit 3. A. Yes. The invention of Hanna was of earlier date than the invention of Robinson and Hewlett, and it is in quit a different class of inventions.

The object which Hanna tried to solve was the same, the reduction of background noise in relation to weak sounds, but he adopted an entirely different course, which I can probably discuss later on.

103 Q. Will you just point out the differences between
Figs. B and C. I assume that Fig. B is a correct
representation of Hanna's recording just as his system would produce? A. Yes.

Q. Will you point out now just the difference between Figs. B and C? A. The main difference is that Hanna amplified the weaker sounds more than the more powerful sounds. So that if the record B is representing the same sound as record C, then the weak sounds are more powerful and consequently the envelope, that is, the curve connecting the peaks of the record, the envelope in Hanna's record will be more flat than the envelope in Robinson and Hewlett's record. That is one characteristic feature of Hanna.

Another characteristic feature which Hanna describes in his invention is that the clear area, the transparent area, is not reproduced according to the volume of the sound, as in Robinson and Hewlett, but is rather increased.

Fig. B shows a positive of Hanna's record, just as Fig. C shows a positive of Robinson and Hewlett's record, and it will clearly be seen that there is much more transparent areas in Fig. B than in Fig. C. So that Hanna did two things, one thing which helped to the elimination of the background noises, that was the relatively larger amplification of the weak sound, but at the same time—

104 Q. (interposing) That would drown out the background noise? A. That would tend to drown out the background noise because the weaker sounds were more amplified, but at the same time he did a second thing, he increased the transparent area, which as I have tried to describe before, will tend to increase the background noise on account of spots and dust in the clear area.

But Hanna's record had one thing in common with Robinson and Hewlett's record, namely, that he displaced the zero line in the same way as Robinson and Hewlett did. He adjusted the zero line in the beginning at the edge of the sound track, and then removed it towards the other edge of the sound track as the sound amplitudes increased. And, therefore, he had the same trouble as Robinson and Hewlett as regards the distortion of sound when the large sounds were cut off.

Q. Will you state whether or not the problem of cut-off of peaks was the same or different in Hanna than it was in Robinson and Hewlett? A. It was largely the same.

Q. In other words, the same distorion as compared to the normal record was introduced by this asymmetric cut-off of peaks in Hanna as we found in Robinson and Hewlett? A. Yes, that is right.

105 Q. And in their records the peaks were on one line near the lower edge of the track, as shown in Exhibit 3, is that right? A. Yes.

Q. Now, I wish you would explain your invention, which is disclosed in this application, as compared to the prior art which we have discussed in connection with Figs. 2, B and C of Exhibit 3, first generally referring preferably to Fig. D of Exhibit 3. A. Our invention was along the same lines as Robinson and Hewlett, rather than along the line of Hanna.

Our object was to reduce the transparency of the sound track, the weaker the sounds are, but we realized the cause of distortion which would be introduced if we allowed this zero line to move in the same way as Robinson and Hewlett did.

Therefore, we limited the movement of the zero line to the center of the sound track. That is, we started as Robinson and Hewlett, with the zero line at the edge of the sound track when there was no sound, and as the sound started and increased, we moved the zero line toward the middle of the sound track, but we did not allow it to pass the middle of the sound track. Thereby we obtained the result that as soon as the sound amplitude became sufficiently large to be susceptible to cut-off, the zero line would be in the middle of the sound track, and therefore the cut-off would be symmetrical and consequently
106 no harmful distortion would be introduced. Now the way we did that I can explain.

Q. Before you do that, Mr. Poulsen, I am correct, am I not, if I say that as far as Exhibit 3 illustrates the one difference between your record and the Hanna-Robinson-Hewlett records— A. (interposing) Oh, yes.

Q. (continuing) —is that neither the lower nor the upper ends of the peaks of the sound are on a straight line, but both are on wavy lines, is that a correct statement? A. Yes; I should have pointed that out, that a consequence of this limitation of the movement of the zero line is that the peaks, the lower peaks of the sound record will not be on a straight line parallel to the one edge of the film, but will be a wavy line, which is symmetrical to the other wavy line to the envelope on the other side.

Mr. Kolisch: This envelope, your Honor, is indicated in each of those figures by the dotted line that connects the peak.

The Witness: So there are really two differences between our sound track and the Robinson and Hewlett sound track. First, the shape of the curve showing the movement of the zero line, and secondly, the shape of the envelope of the sound record.

107 By Mr. Kolisch:

Q. And this, as I understand it, completely solved that problem of a symmetric cut-off of sound peaks that you discussed in connection with Figs. B and C of Exhibit 3, is that right? A. Yes.

Q. Now, I wish you would take up Exhibit 1 and explain in general terms how you accomplished this. A. Yes. If your Honor will look once more on Exhibit 1 on the left hand part of the exhibit, which shows the electrical circuit determining the movement of the oscillograph. As I mentioned before, Robinson and Hewlett used a rectifier in order to rectify parts of the sound responsive alternating current, and thereby produced a variable bias, which controlled the average position of the oscillograph, and thereby the zero line.

Now, what we did was the following: We introduced in series with the rectifier a constant d. c. bias, represented in the figure by a battery, and we adjusted the connections in such a way that the variable bias produced by the rectifier would oppose the constant d. c. bias, so as to reduce the constant d. c. bias the greater the sound amplitudes are. At the same time we adjusted our oscillograph in a different way, whereas Robinson and Hewlett adjusted
108 the oscillograph so that when it was current-less,
when there was no current in it, the edge of the light line would be close to the edge of the track, and we adjusted the oscillograph so that when there was no current in it the end of the light line will be at the center of the track. That is one thing.

Then our second step is to introduce this constant d. c. bias and by means of that to remove the light line so as to be near the one side of the sound track, and then when the sounds are coming in we reduced the constant d. c. bias by means of an opposing variable bias, so that the d. c. bias is gradually reduced, and we adjusted the values, so that just before any cut-off takes place the constant d. c. bias will be reduced to zero, whereby the oscillograph will again be moved towards the middle of the sound track, or I should say the light line will again be removed towards the middle of the sound track.

Q. As I understand it, towards and up to the middle point, but it can never move past that middle point? A. No, not move past that middle point.

Q. And because of your initial adjustment it falls on the middle point? A. On the middle of the track, yes.

Q. Yes. A. That is clear?

109 Q. Yes. Before going into it in detail at this time, I wish you would state whether in any of these patents which were cited by the Patent Office there is any suggestion of a sound track like your sound track shown in Fig. D of Exhibit 3. A. No.

Q. Will you state whether there is any suggestion in any of the patents of the adjustments that you have just described and which you say produce your sound track. A. No, there is no indication of adjusting the light line to the middle of the sound track when the oscillograph is currentless, and there is no indication of a constant bias which is so adjusted as to remove it towards one end of the track.

Q. Now, will you take up your application that was filed, and I refer to the original specification before any amendment and call the court's attention to passages in your description that deal with this phase of the invention? A. Yes. I think the first reference in the specification to the limitation of the zero line is in Paragraph 21.

Mr. Kolisch: I have numbered it in red pencil, your Honor, the paragraphs in the original description. It is a little bit easier to find.

The Witness: It is on page 12 at the top. There it is stated: "The displacement, however, may be smaller
110 or larger than the said amplitudes, preferably—but not necessarily—such that the zero-line can in no case be moved further than up to the middle of the film."

And then again in Paragraph 38—

Q. (interposing) Before Paragraph 38, as I understand it, paragraph 23 discloses in detail the special method of adjustment you have just discussed? A. Yes. Paragraph 23 reads as follows:

"During the recording it is possible to so adjust the recording apparatus relatively to the negative film that the zero-line of the amplitudes at the start, i. e., when the said apparatus is current-less, is situated at the middle of the film. When the recording is initiated the zero-position of the recording device is modified automatically in such a manner that the zero-line is displaced towards one edge of the film and thereafter is re-displaced towards the middle of the film at a rate increasing as the film increases. This displacement may be effected, in the manner hereinafter described, by exposing the recording device to the action of a direct current, which, by the varying current into which the sounds are converted in order to be recorded, is controlled in such a manner that it varies in accordance with the intensity of sound.''

And then in Paragraph 38, on page 17 of the fire wrapper—

111 Q. (interposing) You refer there to the—beginning ''The sound recording device i, h''? A. Yes. May I start from the beginning?

Q. Yes, go ahead. A. (reading) ''The construction shown in Fig. 8 differs mainly from the form of construction shown in Fig. 7 in that the sound recording device i, h is adjusted in such a manner that the zero-line for the amplitudes of the sound record is situated along the longitudinal center line of the film concerned when the recording device is currentless.''

And then it goes on at the end of the paragraph:

''When the resulting grid-bias reaches a value at which the anode current of the tube p becomes nil, and the zero-line is constantly moved towards the middle of the film, then a further increase of the said voltage variation, i. e., still more powerful impulse through the transformer k, will cause no further alteration of the anode current, and, consequently, no further displacement of the zero-line.''

Here again the limitation of the movement of the zero line is outlined.

And in the following paragraph:

''As a result, the zero-line cannot be displaced any further than up to the middle of the film during recording.''

And also in the original claims we find a similar statement in Claim 21; at the end of the claim it is stated:

112 ''so as to cause the zero-line of the recorded sound to be displaced transversely to the film from an initial position at one edge of the film towards the middle of same at a rate increasing for increasing amplitudes of the recorded sounds.''

Q. In your opinion, Mr. Poulsen, do those passages describe the same adjustment and displacement that you have described in connection with Fig. D of Exhibit 3, as contrasted with Figs. B and C of Exhibit 3? A. Yes. There are some further details of Fig. D which I suppose we need not go into on this point, because they have to do with another part of the invention. But those features which I described before are the same as are referred to in those passages of the specification.

Q. And the claims which have been allowed and which Mr. Cochran referred to in his brief opening statement are the claims that deal with the other inventions and other features of the inventions, is that right? A. Yes.

Q. The claims that have been allowed in this application? A. Yes.

Q. Now, I will ask you whether this means the same thing: by this I mean your discussion of Fig. D of Exhibit 3, as contrasted with the prior art means the same thing as the following language, and for your Honor's convenience I am going to read from Claim 72, one of the claims that was rejected, and which I have copied
113 on these sheets: "holding the variations of the average exposure between predetermined lower and upper limits"? A. Yes.

Q. As I understand it, the predetermined lower limit in accordance with your invention is near the edge of the track just as it was in Hanna, Robinson, and Hewlett, is that right? A. Yes.

Q. And the predetermined upper limit in accordance with your invention was the middle of the track as shown in Fig. D, and as distinguished from that neither Hanna, nor Robinson, nor Hewlett had predetermined upper limits, is that right? A. Yes, that is right.

Q. As I understand it, in these prior patents the upper limit constantly varied with the amplitude of the sound, and the louder the sound the higher the upper limit, is that right? A. Yes, or I would rather say there is no upper limit stated.

Q. Now, I wish you would take up the Robinson patent, No. 1,854,159, and point out more in detail with the aid of the patent what you have said generally in connection with Fig. D of Exhibit 3. A. Yes. First, in Fig. 2 of the
114 Robinson patent a sound record is shown having the same characteristics as Fig. D in Exhibit 3.

It will be noted that the peaks of the waves at the clear part of the sound, the transparent part of the sound track, which is shown as white, are all approximately on a straight line, as in Fig. C of Exhibit 3.

Turning now to Fig. 1, which shows the Robinson apparatus for making such a record, your Honor will see that the right hand side of the figure is nearly identical with the right hand side of Exhibit 1, showing the film the lamp (7), and the optical arrangement, the oscillograph loop (25), with the mirror (10), and the light line on the film at 6. In the left hand side of the figure the electrical arrangement is shown.

I will not go into detail, but it is sufficient to say that it contains an amplifier (26) like the amplifier which we have shown in Exhibit 1, and a rectifier shown in the upper end of the picture which is connected to the oscillograph.

There is no constant d. c. bias shown, no such bias is mentioned throughout this specification.

Q. Mr. Poulsen, before you take up the specification of Robinson, the rectifier that Robinson shows in his Figure 1, and described in his specification, is the same as that block marked "Rectifier" in Exhibit 1? A. Yes.

115 Q. And as I understand it, has nothing corresponding to what you have marked in Exhibit 1 "d. c. bias"? A. No.

Q. Now, before you take up this specification, will you state whether or not in your opinion it would be possible to produce what you have described as your invention without such d. c. bias? A. No, it would not.

Q. In your opinion would it be possible to produce with the equipment illustrated or described by Robinson the record shown in your application and also in Figure D of Exhibit 3? A. You could not do that unless you acted contrary to the exact instructions given by Robinson in his specification.

Q. Will you now take up those instructions in detail? A. I find here on page 2 of the patent, line 35, the following passage: "I have found that the clear area of the positive sound record may be reduced to a minimum by adjusting the galvanometer to cause the exposing light beam to take a position scarcely covering any portion of the width of the sound track when no sound is being recorded and by causing the zero position of the galvanometer when it is vibrated with response to the sound, to move towards the center of the sound track."

Here he states that the initial position of the recording light should be scarcely overlapping, scarcely covering any portion of the width of the sound track. 116

Q. This galvanometer, Mr. Poulsen, to which Robinson refers, is the same as the oscillograph to which you referred before? A. Oh, yes; I should have said that. A galvanometer is sometimes used instead of an oscillograph as a designation of the loop.

Q. The function and theory of them are both the same, whether one or the other is used? A. The oscillograph is considered a special form of the galvanometer. A galvanometer is a broader expression.

Q. Now, referring to the passage that you just read from the Robinson patent, will you compare it with the instructions that are contained in your application forming the subject matter of this suit? A. Yes. According to our patent application the initial position of the galvanometer should not be so as to cause the light beam to be near the edge of the sound track, but it should be so that it is in the center of the track, whereas Robinson has stated that it is near the edge of the track.

Then again on page 2, line 85, he states:

"The purpose of this apparatus is to superimpose upon the normal sound responsive current fed to the galvanometer a suitable rectified component thereof."

117 He does not mention any constant bias. He is just super-imposing a rectified component of the sound responsive current.

Q. Which, as I understand it, constantly caries with the rising and falling of the sound? A. Yes. On page 2, line 102, he states:

"I then adjust the zero deflection position of the galvanometer so that when there is no sound being recorded the light beam laps over a small fraction only of the sound track which in the positive appears as the narrow clear line 24."

This is more or less the same.

Q. As distinguished from that in your system and in accordance with your adjustment of your galvanometer when there is no sound recorded, what will be the position of the light beam? A. When there is current in the oscillograph, the position will be in the center of the track.

Q. That is to say, it will overlap half of the track instead of a very small portion as Robinson instructs you to? A. Then when sound is recorded we move it out to the edge of the track, then by means of the rectified portion move it back again.

Q. All right. Continue. A. On the same page, line 113, he states:

118 "The rectifier may be adjusted so that the rectified current equals the normal alternating current sound current, is greater, or is less than the same as conditions require."

And he continues a little further down:

"While I have obtained satisfactory results in using the arrangement shown whereby I believe the value of the rectified current which displaces the zero deflection position of the galvanometer corresponds approximately to the average value, I may in such cases prefer to make use of any of the well known arrangements to make the shifting of the zero responsive to the peak value of the sound current instead of the average value or to even use the R. M. S. value."

Robinson here is speaking about the various values of the sound responsive alternating current. One distinguishes between the peak value, which is the maximum value of an amplitude, and the average value, which is the average value of all the single values of the current over a period and the R. M. S. value, which is a technical expression for the equivalent d. c. current, that is, the R. M. S. value is that value of a corresponding d. c. current which has the same effect as an alternating current. These are three various values of an alternating current used in technical language, which more or less approach the peak value, or the maximum value, but they are all changing in proportion to the maximum value, which is the most important thing in this connection.

119 Q. In other words, as I understand it, no matter which one of these values we select, the variation of the zero line will be always proportional to the sound amplitude and always in accordance with the volume of the sound. A. Yes.

Q. Do you find any echo of these instructions in the claims? A. Yes. Robinson states in Claim 4, on page 4, that the peaks of the opaque portion of the record extend to the side of the sound track irrespective of variations in the volume of the recorded sound. If you compare that expression with Fig. C—

Q. (interposing) Fig. C of Exhibit 3? A. Yes, Fig. C of Exhibit 3, this is equivalent to saying that the lower peaks of the amplitudes are located on a straight line parallel to the edge of the sound track.

And then again in Claim 5 he states that the axis of the record is receding from the side of the sound track bounding the clear side of the record in accordance with the volume of the recorded sound.

In Claim 6 he mentions "means for supplying to said means for the control of an alternating current corresponding to the sound wave to be recorded and a direct current in response to the sound." The same expression he has used in Claim 7. Here he says:

"A direct current variable in accordance with said
120 sound wave."

Then, in Claim 10, in the last line he says: "and for producing an additional lateral displacement of the beam in accordance with the volume of the sound."

All of these expressions amount to the same, as has been stated before, in connection with Fig. C of Exhibit 3.

Q. Now, will you take up the drawings of your application, and referring specifically to Figs. 3, 4, and 5, will you compare them with what you have said before, and also with what you have generally illustrated in Exhibit 1? A. I will refer to the modified figures.

In Fig. 3 of our drawings there is shown a battery "O" in series with the oscillograph loop "D".

The same is the case in Fig. 4 and Fig. 5. This constant battery is equivalent to the constant d. c. bias which I mentioned before in connection with Exhibit 1.

On this biasing potential is superimposed a rectified component of the alternating current, which is opposing this bias, so as to reduce it to zero at a certain amplitude.

This rectified component is produced in a different way in Figs. 3, 4, and 5.

All three figures show a rectifier and a smoothing circuit for smoothing out the ripples of the rectified current.

And it is seen that the direction of the rectified current is in all cases so as to reduce the constant bias.

121 Q. Have you finished with that? A. I think so, yes, unless your Honor wants me to go more into detail.

Q. Will you first explain what Exhibit 2 illustrates? A. Exhibit 2 illustrates the way in which the bias affecting the average position of the galvanometer is varied.

First, in Exhibit 2, the sound current itself is shown as a wavy line, which is changing on both sides of zero. Then there is shown the d. c. bias, the variable d. c. bias, produced according to Robinson and Hewlett. This variable bias is in accordance with the peak value of the sound, and is therefore following the envelope of the sound current curve. Now, as distinguished from this, the bias applied according to our patent starts with a certain value, and is decreasing as the sound volume decreases, and at a certain value of the sound it goes down to zero. Then it stays at zero value all the time while the sound is at maximum value, and at a certain value of the sound it again increases, and it increases up to the same value at which it started.

These curves show very clearly what is the difference between the bias applied according to Robinson and Hewlett, and the bias applied according to our invention.

At the same time I may point out that there is a difference in adjustment of the oscillograph.
122 According to Robinson and Hewlett, the oscillograph is adjusted near the edge of the sound track when there is no current through it, and according to our invention, it is adjusted to the middle of the sound track when there is no current through it.

The Court: That line expressing the d. c. bias of Robinson and Hewlett is not really in accordance with Robinson and Hewlett's claim because that goes to the end of the high point of the volume and magnitude of sound.

The Witness: Yes, that would be according to the peak value of the sound.

The Court: But they did not say that it goes to the peak value. That is Exhibit 2 you are talking about, is it not? That d. c. bias of Robinson and Hewlett does not look like that. It would come a quarter of an inch or a half an inch down lower.

The Witness: You say is it in accordance with them?

The Court: Take the Robinson and Hewlett line on Exhibit 3, Fig. C, and it does not go to the peak, does it?

Mr. Kolisch: If I may—

The Court (interposing): Well, I am asking the witness.

The Witness: That is quite true.

The Court: It would mean exactly the extreme idea of Robinson and Hewlett?

123 The Witness: That is quite true. Actually, it should be only half of that. The current corresponding to the bias is only half of the peak value.

The Court: Yes, that is right.

The Witness: May I call the attention of your Honor to Fig. D again?

The value of the bias is half the value of the total peak, the total swing.

What we have shown here in Exhibit 2 is also half the value of the total swing.

The Court: I understand now what you mean.

By Mr. Kolisch:

Q. Is the configuration of the curve of the Robinson and Hewlett d. c. bias and your d. c. bias, as shown in Exhibit 2, correct?

The Court: No. He says it ought to be one-half down from the peak sound curve. Is that right?

The Witness: No. I was wrong, your Honor, when I said that, because actually the bias is equal to the peak value as measured from the zero line up to the maximum, and that is also the case in Fig. D of Exhibit 3.

By the peak value you understand it is not the total swing, but the value of the amplitude from the zero line and up to either peak, either positive or negative peak.

The Court: I know, but your zero line goes along
124 the middle of the film, is not that right?

The Witness: Yes, as additionally adjusted.

The Court: Yes, it starts there.

The Witness: Yes.

The Court: Now, the Robinson and Hewlett zero line does not go to the extreme peak of the sound current, does it?

The Witness: Yes. It is in accordance with the peak value.

The Court: It is in accordance with it, but it does not go that far. It keeps within the film, does it not?

The Witness: I believe there is some misunderstanding there, your Honor.

Your Honor understands by the peak value the value from the lowest point and up to the highest point.

The Court: Yes.

The Witness: But that is not what is understood usually by the peak value.

The peak value is the value from the zero line and up to the highest point, or from the zero line and down to the lowest point. That is the peak value, and that is also the peak value which is shown here in Exhibit 2.

By Mr. Kolisch:

Q. May I ask this question that might clarify it: In Ex-
hibit 3, Fig. D, you are, as I understand it, illustrating by
that dotted wavy line, the zero line about which the
125 oscillograph will oscillate, and the mirror will oscil-
late, is that right? A. Yes.

Q. And that zero line will be going up but it will naturally never assume any other position than mid-way between the two ends of the amplitudes, is not that right? A. Yes, sir.

Q. Because it is the point about which you vibrate the mirror? A. Yes, sir.

Q. Now, as I understand it, as distinguished from that, the curve shown in Fig. 2 is not the zero line, it is the direct current that you are feeding into your oscillograph to cause it to vibrate, is that right? A. Yes.

Q. Now, as I understand the Robinson disclosure, this direct current is always proportional to the sound current, it is taken direct from it and fed direct into the oscillograph. Since that is so it can be represented by a curve following the peaks of the sound, is that right? A. Yes.

Q. In other words, a current produced in accordance with
the curve shown in Exhibit 2 will distort or change the
sound current illustrated in Exhibit 2 into a sound
126 current record such as is shown in Fig. D of Exhibit
3, is that right? A. Yes.

Mr. Kolisch: I do not know whether that makes it clearer to your Honor.

The Court: I know; I hear what you are saying, and I hear what the witness says. Of course I know what he is saying.

By Mr. Kolisch:

Q. Now, Mr. Poulsen, you said a minute ago when you took up the detailed disclosure of Robinson that if one practiced your invention with the Robinson disclosure, one would be running contrary to Robinson's instructions. Will you say why that is so? A. Because Robinson nowhere states that a d. c. bias should be applied.

Q. You mean a constant d. c. bias should be applied? A. That a constant d. c. bias should be applied, and he does not show anything in his figures which indicate the presence or the possibility of a constant d. c. bias.

It would also be contrary to his instructions as regards the adjustment of the oscillograph, because he has adjusted the oscillograph so that its initial position is near the edge of the film.

Q. And how about the position of the peaks on a straight or a wavy line? A. Oh, yes. Also, he says repeat-
127 edly that the peaks should be approximately at a straight line, and he shows it in Fig. 2, which would be contrary to our instructions in accordance with Fig. 2 in Exhibit 2.

Q. Now, will you please take up the Hewlett patent, No. 1,853,812? A. The Hewlett patent is of a little later date than the Robinson patent, and only shows a slight modification of the Robinson invention.

The sound track produced by Hewlett is the same, as will be seen from Fig. 2.

In Fig. 2 it will be seen that the peaks at the clear side of the sound track are all approximately on a straight line.

In Fig. 1, which shows the apparatus with which he makes his record, the optical part is identical with the optical arrangement shown by Robinson. And the only difference is in the electrical circuit.

Q. Now, before you take up the electrical circuit, Mr. Poulsen, will you tell us whether or not Hewlett applies a biasing potential always in accordance with the variations in the sound current, just as Robinson did? A. Yes.

Q. Or whether he differs from Robinson. A. No. He does exactly the same as Robinson.

Q. Will you briefly refer to various passages of
128 the specification where Hewlett makes this claim? A. For instance, on page 2, line 87, he says:

"So as to produce a substantially uniform biasing of voltage whose value depends upon the peak value of the signal waves."

Q. Will you compare this instruction with Exhibit 2 and the illustration of the d. c. bias of Hewlett and Robinson as illustrated there? A. Yes. That is exactly the same as Robinson does, produce a bias in accordance with the peak value of the signal waves, and therefore in accordance with the envelope of the sound current curve shown in Exhibit 2.

Q. Signal waves or sound wave currents are the same, are they not? A. Yes, they are the same, sound waves and signal waves.

Q. All right. Continue. A. And he goes on on page 2. He goes on a little further and says in line 92:

"The magnitude of the signal received by amplifier 34, amplifier 25 through the resistance 29 is so chosen that the peak values of these signals are just equal to or are a little less than the bias produced."

The only difference between Hewlett—

Q. (interposing) Before you compare them I wish you
would say whether the claims of Hewlett have any-
129 thing to say about the value of this biasing cur-
rent. Take, for instance, Claim 1. A. Yes. In Claim
1, line 72, he claims:

"Means for varying said zero in accordance with the peak value of said waves."

Q. Then, as I find it, the same thing is true for Claims 2, 3, and 5, is not that right? A. Yes.

Q. Will you now point out the differences between Hewlett and Robinson? A. Not Claim 5, but Claims 1, 2, and 3. Claim 5 is on a different item.

The difference between Robinson and Hewlett lies in the electrical circuit. Whereas, Robinson had an amplifying circuit and a rectifying circuit connected directly to the loop, the Hewlett patent shows a rectifying circuit acting through the intermediary of an amplifier valve on the oscillograph. The rectifying circuit is acting on the grid circuit of this amplifying valve, and the oscillograph is inserted in the plate circuit of the amplifying valve. Therefore, there is a source of constant direct current bias in series with the loop, namely, battery 42.

This source of d. c. bias would produce a permanent deflection of the oscillograph if it were not for the fact that
Hewlett is nullifying this bias by means of another
130 d. c. source, namely, battery 43 in series with resis-

tance 44. And he definitely states in his specification that that is the purpose of 43 and 44.

On page 2, line 110, he states:

"The loop is by-passed by the battery 43 and resistance 44 in series so that the steady plate current of the amplifier 34 may be balanced out."

And equally in Claim 5, page 4, line 5, he claims:

"Means connected with said galvanometer for balancing out tje plate current of said amplifier when there is no sound."

So, not only has Hewlett no biasing current, but also the biasing current which he could have had is deliberately balanced out by the application of an opposite d. c. bias.

Q. In your opinion if one operates the Hewlett system so as to use this constant d. c. bias instead of balancing it out, would one be acting in accordance with Hewlett's instructions or not? A. One would be acting contrary to them.

Q. Does the Hewlett patent contain any language which would indicate that a variation from the instructions that you just read would be permissible? A. No. Everything in his description is in accordance with this balancing out of the bias; also, the instruction as to the adjustment of the oscillograph, of the initial position of the oscillograph.

Q. Do you happen to know, Mr. Poulsen, what Mr.
131 Hewlett's and Mr. Robinson's positions are in this
art? A. As far as I know, they are very outstanding inventors and experts in this special art of sound recording, and are particularly renowned inventors in connection with silent recording.

The Court: Both are evidently employees of the General Electric Company, are they not?

The Witness: Yes.

The Court: And they both filed the two applications for patents by the same attorney, and they probably collaborated together. Would not there be an indication of that?

The Witness: Yes, they got the same results.

The Court: And both the patents were isued the same day?

The Witness: Yes. And it looks as if Hewlett is considering a further development on the problem.

The Court: In other words, Robinson found out this one thing at a time, and Hewlett found this modification of it, and the two of them applied for patents, first Robinson, and then Hewlett, through the same attorney, and they are both employed by the same company, and they both assigned their two patents to the General Electric Company, is not that right?

The Witness: Yes, certainly.

The Court: That is all.

132 By Mr. Kolisch:

Q. Now, will you take up the Sacia patent, No. 1,623,756? A. The Sacia patent belongs to another group of inventions, which had for its same object to reduce the background noise. The invention of Sacia has nothing to do with the reduction of the transparent area, but it goes at it in an entirely different way.

Instead of reducing the background noise in relation to the volume of the sound, he is increasing the volume of the sound for the weak sounds.

Mr. Cochran: If your Honor please, if it will save your Honor's time, he need not discuss that patent, as we will not rely on it in our argument, but I have no objection to him going into it if he wishes to do so at this time.

The Court: We might state briefly about it. Just state briefly about it. In other words, he bases his patent on the fact that he makes the sound he wishes to record louder, amplifies it louder so as to shut off the background noise?

The Witness: He us amplifying weaker sounds more than louder sounds, because they need it more than the louder sounds.

The Court: But the background noises are still there?

Mr. Cochran: I beg your pardon, your Honor. I
133 did not hear.

The Court: The Government now says it does not rely upon the Sacia patent.

Mr. Cochran: No, sir.

The Court: How much longer will you be?

Mr. Kolisch: I think we can finish this afternoon.

The Court: I could sit through for a half an hour, but I want to take time for lunch.

Mr. Kolisch: I may take about an hour and a half longer.

The Court: If that is the case we better adjourn, until 1:30, and you can finish it then within an hour or so.

(Whereupon, at 12:30 o'clock p. m. a recess was taken until 1:30 o'clock p. m. of the same day.)

134 *Afternoon Session*

The court reconvened at 1:30 o'clock p. m., pursuant to the taking of recess at noon.

The Court: You may proceed.

Mr. Kolisch: Mr. Poulsen.

Whereupon **Arnold Poulsen**, the witness on the stand at the time of taking a recess, resumed the stand and testified further as follows:

Direct Examination (Continued)

By Mr. Kolisch:

Q. Mr. Poulsen, will you now take up the Hanna patent, No. 1,888,724? A. Yes, Hanna had exactly the same idea as Sacia, except that instead of making two records like Sacia did, he combined the two records into one record.

As is seen in Fig. 1, which is a negative of the record Hanna made, he is making a main record of the sounds, and as stated in the specification, he is amplifying the weaker sounds more than the stronger sounds, so as to level out the differences between the amplitudes in the sounds. At the same time he is displacing the zero line in the record in accordance with the distorted sounds so that the peaks of the sounds on one side will all be on a straight line close to one edge of the sound track.

135 Now, this displacement of the zero line he is using in reproduction. He is first making a print of his negative, as shown in Fig. 2, where the black area is transformed into a white transparent area, and in reproduction he is passing that sound record in front of the light line. Now this record will produce, first variations in the light according to these distorted amplitudes, and secondly, it will cause variations in the d. c. current of the photoelectric cell, and these variations in the d. c. current of the photo cell are used to modify the amplification of his reproducing amplifier so as to counteract the distortion or the unequal amplification which he had in recording. Therefore, the weak sounds now during reproduction will be less amplified than the stronger sounds, and the same relation which originally existed between the weak sounds and the strong

sounds will be reestablished. So, consequently, Hanna is actually doing the same thing as Sacia, with his two records.

Q. Mr. Poulsen, are you familiar with the various sound recording schemes that went into commercial use throughout the world? A. Yes.

Q. Do you know whether the Hanna or Sacia scheme ever went into use anywhere? A. I have never seen myself a record made according to Sacia and Hanna, and so far as I know, they were never carried outside the labora-
136 tory. They were just used for experimental purposes. Shortly after Hanna, Robinson came out with his invention, and his invention with the improvements later on introduced according to our invention has been used commercially all over the world.

Q. Do you know specifically whether the assignee of Hanna, the Westinghouse Electric Company, or the assignee of Sacia, the Western Electric Company, have ever used commercially the schemes disclosed in these two patents? A. To my knowledge they did not. And shortly after Hanna took out this patent, he took out another patent, which was more along the lines of Robinson.

Q. Has your invention ever gone into commercial use? A. Yes, sir. It has been used from the beginning of noiseless recording, just as soon as noiseless recording was adopted by the companies exploiting our invention.

Q. And where has it been used? A. It has been used throughout the Scandinavian countries, in England, and in the English Colonies.

Q. How about the use in the United States? A. It has been used to my knowledge everywhere where silent recording along the lines of the patent of Robinson has been used, that is in all systems where a displacement of the zero line has been used to reduce the transparency off the sound track.

137 Q. When was that use started in accordance with your invention, I mean that modification of Robinson? A. Well, we started in August, 1930.

Q. Do you know whether anyone before your invention used Robinson in accordance with your invention, the changes introduced by your invention? A. No, so far as I know, nobody did.

Q. Have you obtained patents on this invention in other countries? A. Yes. We applied for patents according to this invention in all important countries of the world, and in no place has the patent been refused. Our application is still pending in some countries, for instance, in Germany and Canada, but everywhere where the application is through we have been allowed claims similar to the claims in this suit.

Q. Now, referring again to Hanna's Figs. 1 and 2 in the Patent Office, the contention of Patent Office officials was at least at one stage of the game that Hanna in Fig. 1 really intended to illustrate a positive record and not a negative
record; is that contention correct? A. No. I do not
138 see that contention confirmed anywhere in the specification. On the contrary, it is definitely stated in many places that Fig. 1 is the negative and Fig 2 is the positive.

Q. Will you quickly refer to the passages where Hanna states this? A. First, on page 2, line 2, he states:

"Figure 1 is a view, partially in section and partially diagrammatic, of a portion of the negative of a photographic sound record.

"Fig. 2 is a similar view of a positive corresponding to the negative in Fig. 1."

And then later on in the same column, line 24:

"The sound record 8, represented by the clear area in Fig. 2, corresponds to the darkened area in the negative represented by the shaded area 9 in Fig. 1."

And, further, there are several other places, for instance, page 2, line 96, second column:

"which is made by printing a positive, like that shown in Fig. 2, from a negative, like that shown in Fig. 1."

And perhaps the best reference is here on page 3, line 123:

"The film having been exposed in the apparatus shown in Fig. 3 is developed and printed, thus producing a record like that shown in Fig. 2."

And again on page 4, line 18:

139 "The sound record represented near the bottom of Fig. 2 which corresponds to the record of faint sounds, presents a relatively wide band of clear film."

Here it is definitely stated that where the sounds are weak there should be a relatively wide band of clear film. That shows in my opinion that Hanna was not at all at this moment interested in reducing the noise by reducing the clear area of the film. And, therefore, it is quite consistent with his invention that Fig. 1 is a negative and Fig 2 is a positive.

Q. Now, will you compare Hanna's record with the record produced in accordance with Robinson and Hewlett? A. Yes. First, the record, as I have stated, is the opposite in the sense that where the Robinson-Hewlett record has a great darkened area, the sound track of Hanna has a great transparent area.

Then, again, as is seen on Exhibit 3, by comparing Figs. B and C, the Hanna record will show a smaller difference between the amplitudes than the Robinson and Hewlett record. That is, the envelope of the Hanna track will be more flat than Robinson and Hewlett's track, but they are similar in the respect that the zero line is displaced up to the edge of the film when there is no sound, and then displaced according to the volume of the sound as the sound increases, so that the lower points of the record will all be
approximately in a straight line parallel to the first
140 edge of the track.

And as regards the asymmetrical cut-off, which is taking place in the Robinson-Hewlett record at large amplitudes, the case is the same with the Hanna record. The distortion is the same in the Hanna record.

Q. Does the Hanna patent in its claims say anything concerning the relative position of the peaks? A. Yes, both in the specification and in the claims it is stated that the lower part of the peaks should be on a straight line parallel to the edge of the sound.

Q. For instance in Claim 6? A. Yes. I do not find it just now in the specification. But in Claim 6 at the end of the claim it is stated, in line 36:

"Means responsive to said phenomenon for so varying the mean position of that boundary line of the record which is defined by said peaks that the tops of said peaks attain substantially a common level."

And then again in Claim 7, at the end:

"Said electrical disturbance and said microscopic variation being so related that the tops of said peaks are at substantially a constant level."

He is just using a slightly different wording here,
141 meaning by disturbance the constant displacement,

and by microscopic variation the quick instantaneous variation.

Q. Do you find in Hanna any statements as to the manner in which the zero line should be displaced as related to the sound current or sound amplitudes? A. Yes. That is stated in Claim 9. In line 78 he claims:

"Means for impressing a record of said electrical energy on a permanent medium, and means for varying the zero boundary of said record in accordance with the amplitude of said impressed sound energy."

And there are similar expressions in the specification to the same effect.

Q. Now, referring to the Hanna patent, possibly with the aid of Exhibit 2, will you explain the manner in which Hanna applies his d. c. bias? A. Yes. The electrical circuit used in recording is represented by Fig. 3 of the Hanna patent.

It will be seen that in Fig. 3 there is an amplifier (18), supplying the sound responsive alternating current to the oscillograph, which is designated by 25.

At the same time rectified current is applied to the oscillograph through the rectifier valve (30) at the bottom of the diagram. That rectified current consists of d. c. current,
which is modified by the alternating current impulses,
142 as shown in Exhibit 2. It starts with some value, a
certain value, which is not defined in the specification, so it could be any value. That is the value of the plate current in the rectifier tube (30). When sound impulses are coming in that plate current is reduced in accordance with the amplitude of the sound alternating current, so that the bias varies according to the curve shown in Exhibit 2. That curve is of the same form as the envelope of the sound current in the same Exhibit 2.

When the sound decreases the plate current of the d. c. bias is again returning to the original value. So here we have a d. c. current which is reduced in accordance with the volume of the sound.

Q. Do you find in Hanna any instruction or suggestion that the variation be otherwise than in accordance with the sound amplitude? A. No. And there is no indication that that plate current should be reduced to zero at maximum value or to the effect that the adjustment of the galvanometer should be so as to place the zero line in the middle of the track when there is no current, as we do in our invention.

Q. It has been suggested during the prosecution of your application by the various tribunals of the Patent Office that the bias control in Hanna might be adopted in or combined with the Robinson and Hewlett disclosures.
143 What have you to say as to the possibility or probability that one skilled in the art would effect such combination? A. It would be contrary to the instructions in the Robinson and Hewlett patents, because in these patents it is stated that the bias should be in accordance with the volume of the sound, whereas in accordance with the Hanna patent the bias would decrease inversely as the volume of the sound increased.

Q. If such combination were effected contrary, say to the instructions of the patents, what would the resulting record look like? A. If I understood you aright, if the way of biasing used by Hanna were used by Robinson and Hewlett?

Q. Yes. A. It would all depend upon how Robinson and Hewlett would adjust the zero position of their galvanometer.

Q. If they adjust the way Hanna says it should be adjusted, what would be the result? A. Hanna does not say in what way it should be adjusted.

Q. If adjusted the way Robinson and Hewlett say it should be adjusted, what would be the result? A. If adjusted so that the zero line is near the edge of the sound track when there is no sound, then it would be moved according to the volume of the sound.

144 Q. In other words, could you use them in combination? A. It would be moved in accordance with the volume of the sound exactly in the same way as it is moved by Robinson and Hewlett if there is adopted the same adjustment.

Q. Now, the Board of Appeals in its decision said as to Claim 70 on page 7 of its decision—I am quoting—"It is not clear to us what the claim means, and for the reason given by the Examiner the rejection appears properly made." Will you please take Claim 70 and explain what it means? A. Claim 70 reads as follows:

“A system for recording sounds on a light sensitive film comprising means for converting sounds into an alternating current, a light source, means to concentrate a beam of light from said light source onto the surface of the film so as to form thereon a transversely disposed linear strip of light.”

That is the old art.

Then it goes on:

“Means to cause the exposure of the film to vary in accordance with the alternating current, a rectifier rectifying a portion of said alternating current, and a smoothing circuit through which the rectified current influences said sound recording means to cause the exposure to vary dependent upon the volume of sound.”

That is all known art. That is what is known,
145 according to Robinson and Hewlett.

The last sentence specifies our invention as follows:

“The electrical constants of the rectifier and said smoothing circuit being so adjusted that the time constant of the total rectifying circuit is of smaller value when the rectifier is operative than when it is inoperative.”

That expression that the rectifier is operative or inoperative was held vague or meaningless by the Examiner. But it is well understood by those skilled in the art that a rectifier is operative when a current is flowing through it, and inoperative when no current is flowing through it.

A rectifier has the quality to pass currents of a certain direction and to stop currents of the opposite direction. When the current is flowing in one direction through the rectifier, the rectifier has a finite resistance, and when the current is flowing in the opposite direction it has practically an infinite resistance.

Now, it might be asked whether that modifies the time constant, since it is stated that the electrical constants of the rectifier and said smoothing circuit are so adjusted that the time constant of the total rectifying circuit is of smaller value when this rectifier is operative than when inoperative, I say it may be asked whether it affects the time constant that the rectifier is operative or inoperative. That is so
because the time constant of a rectifying circuit is
146 determined by the values of the resistance and the
capacities entering into that circuit. Since the recti-

fier has a different resistance when it is operative than when inoperative, when there is current flowing through it than when not, the time constant will be different in the two cases.

Our claim states that the electrical constants of the rectifying circuit should be so adjusted that the time constant is smaller when the rectifier is operative than when it is inoperative.

Q. Mr. Poulsen, would the meaning of Claim 70 be the same if the last clause of the claim were modified to read: "This smoothing circuit being so adjusted that the time constant of the total rectifying circuit is of smaller value when the current is flowing through the rectifier than when no current is flowing through the rectifier"? A. Yes, that would amount to the same.

Q. The same as at present? A. Yes.

Q. Do any of the patents of the prior art that we have considered here disclose or suggest the arrangement so defined in Claim 70? A. No. None of the patents mention any difference in the time constant or the importance of any difference in the time constant, according to whether
147 the rectifier is operative or non-operative.

Q. Now, refer to Claim 49. As to this claim the Board of Appeals held that the systems of the prior patentees of necessity had the two limits that the claim defines. Will you please discuss the claim with that object in mind? A. I believe that the Board of Appeals has been referring to this passage in the middle of the claim:

"the apparatus being so adjusted that the zero line of the sound trace takes up such an initial position relatively to the sound track that, when the plate current attains a zero value, the zero line moves from the said initial position to the center line of the sound track."

That is in accordance with our invention, as I have explained several times before, and not in accordance with any of the specifications cited in the case, because none of these specifications have limitation on the movement of the zero line, none of them could claim that the zero line moves from said initial position into the center line of the sound track.

Q. Now, further on the claim defines the adjustment of the apparatus. Will you briefly refer to that and discuss it in connection with your disclosure, and then in connection with the disclosures of the prior patentees? A. I believe the passage I just mentioned is the passage referring to the adjustment. Is not that so?

Q. Yes. A. "the apparatus being so adjusted that
148 the zero line of the sound trace—"

Q. I refer now to the balance of the claim giving values for resistance. A. Oh, I see. At the end of the claim there is added the following passage:

"in which the loop of the moving system of the oscillograph is connected in the plate suface of the thermionic tube in series with two ohmic or inductive resistances, which are arranged one on each side of the loop, with a condenser connected across the said resistances and the loop, in order to prevent current of audibile frequencies in the plate circuit from affecting the mean position of the moving system of the oscillograph."

This is a rather restricted claim, referring to certain details of our circuit, which are not to be found in any of the cited patents. It refers to Fig. 4, where in the plate circuit of tube p two resistances (q) are inserted in series with the oscillograph, and a condenser (r) is connected in parallel to the two resistances and the oscillograph.

The object of this arrangement is to eliminate from the oscillograph any trace of audible current which may have been left in the rectified current which is applied to the loop as a result of the rectification and the smoothing of that rectified current.

149 When you rectify a current, it will have a wavy curve. It is consisting of all the half waves, for instance, all the positive half waves, of the alternating current, and therefore, it will be a pulsating current.

Now, these variations would be audible if they were not smoothed out, and therefore a smoothing circuit is applied in connection with the rectifier, but there may be still some small traces of alternating current left, and it would be harmful to add them to the original alternating current in the oscillograph. If you did not eliminate them entirely, they would go into the record and produce some distortion, and therefore this arrangement has been added in order to entirely eliminate any trace of ripples in the rectified current.

This is not found in any of the references cited in the case, and I believe there has been some misunderstanding in the Board of Appeals as to the object of this circuit.

Q. The resistances and the inductances and the capacities with which the prior patentees deal, will you state how these are connected or in what portions of their circuits they are connected? A. They are all forming part of the smoothing circuit in connection with the rectifier.

For instance, in the Robinson patent the inductances 40 in Fig. 1 are inserted in order to smooth out the ripples.

150 And in Hewlett's patent, resistances 36-38 and the condenser 37 are inserted in order to smooth out the ripples.

Also in Hanna an inductance 33 and condensers 34 are shown in the smoothing circuit, but they are all placed in the smoothing circuit.

Q. In the smoothing circuit of the rectifier? A. In the smoothing circuit, yes, and they are all affecting the time constant of the rectifying circuit.

Q. And will you state it again as distinguished from that, what your patent does? A. As distinguished from ours, which are inserted in the plate circuit in which the oscillograph is inserted, and are distinctly separate from the rectifying circuit.

Mr. Kolisch: That is all.

## Cross Examination

### By Mr. Cochran:

Q. Mr. Poulsen, in designing this recording apparatus, is it not possible to control the throw of the oscillograph by properly selecting the number of amplifying tubes or by properly selecting the oscillograph? A. It is possible to limit to a certain extent the throw of the oscillograph, whereby I suppose you are meaning the amplitude of the swing, the full swing?

151 Q. Yes, that is right. A. Such current limiting devices are used in practice.

Q. They are not used in practice? A. Yes, they are used in practice.

Q. They are used in practice? A. But to whatever extent you are using such limiting devices, you can never avoid sudden increases in sound which cause a sudden sound to go outside the border of the sound track, and it is not possible to avoid it.

Q. You would say then there are certain sounds of such loudness that almost regardless of the design of the apparatus, the swing will be beyond the film? A. Yes, that is so.

Q. Would you say it is possible to design the apparatus so that for the sounds usually expected would be on the film? A. Yes, but it depends on the skill of the operator to a great extent. It depends upon what level he is choosing for his normal sounds.

Q. With reference to the Hanna patent, I believe you testified that Fig. 1 represents a negative film and Fig. 2 represents the positive? A. Yes.

Q. But have you considered the statement made near the bottom of page 4, the first column, beginning in line 57? A. Yes.

152 Q. What would you say the effect of that is? A. Yes, I have noticed that statement, but that statement should be read in connection with a subsequent statement of the next paragraph, if you will allow me to read the two sections.

Q. Yes, sir. A. In line 57, it is stated:

"By reversing the connections from the grid and filament to the resistor either at the tube 15 or the tube 54, the negative, instead of the positive, may be used for reproduction."

Now, if you would stop there you would assume that you could use the negative as it is shown in Fig. 1 in connection with the reproduction, and in that case you would have a record with a reduced transparency of the film at weak signals.

But you will have to continue, and in the following paragraph it reads:

"The system, with the connections then reversed and the oscillograph adjusted for the zero current position near the sprocket-holes instead of near the picture-record, as shown in Fig. 1, will produce a negative in which the crests near the edge of the film will follow approximately a straight line. The shift of the mid-point of the successive undulations with changing amplification, being in the opposite sense when the connections to resistor are reversed,
153 the average degree of darkening of the negative, as a whole, now decreases instead of increases with faint sounds."

What he obtains by reversing his connections and doing all of these things he describes is to obtain a negative record in accordance with the present Fig. 2.

So then again his object is to produce a sound track according to Fig. 2. I may add that there is something wrong in the first passage. There is a misstatement there, but we are overlooking that.

Q. May I ask you this, distinguishing your device now from the Hewlett and Robinson device in order to move or remove the zero line of the amplitude over to the edge of the film, you provide a d. c. bias to do that? A. Yes.

Q. Which is more or less nullified by the varying current coming from the tube? A. Yes.

Q. In accordance with the amplitude? A. Yes.

Q. With the sound or the volume of sound? A. Yes, that is right.

Q. On the other hand, Robinson and Hewlett, instead of having that electrical bias which you have, they have what
might be termed a mechanical bias, and would you
154 say that is true, that they initially set the oscil-
lograph to have the zero line on the edge, and would
that be a fair distinction between the devices? A. Yes.

Mr. Cochran: I think that is all, your Honor.

The Court: Is that all?

Mr. Kolisch: There are just a couple of questions.

### Redirect Examination

By Mr. Kolisch:

Q. Mr. Poulsen, Mr. Cochran asked you about abnormal sounds which your invention takes care of. Do these abnormal sounds occur in records that are normally made, or do they occur only very rarely? A. Do they occur?

Q. These abnormal sounds, how often do they occur in sound recording? A. Very rarely, you say?

Q. Yes. A. They occur very often. If you look at a sound track, unless it is a long passage of even speech, to which it is rather easy to adjust the apparatus, you will always have these cut-offs, particularly in music or noise.

Q. But in the average film that is produced? A. You will have many of them.

155 Q. In the music? And speech? A. Yes.

Q. Do you have it in every reel always, and how often? A. Oh, no, but very often, particularly with music, and it is particularly harmful to the music.

Mr. Kolisch: That is all.

The Court: The Court will take the case under advisement.

You did not make any formal offer of these exhibits, but I take it you want to offer Exhibits 1, 2, and 3. Do you also wish to offer this (indicating)?

Mr. Kolisch: Yes, the file record.

The Court: The file from the Patent Office records.

(The plaintiffs' exhibits heretofore referred to were thereupon received in evidence and properly marked.)

The Court: Then you wish to offer your Exhibits A, B, C, D, E, F, G, and H?

Mr. Cochran: Yes.

The Court: Comprising the patents you claim would cover this?

Mr. Cochran: That are of record in the application.

The Court: And the record of it?

Mr. Cochran: Yes, sir.

(The defendant's exhibits heretofore referred to were thereupon received in evidence and properly marked.)

156 Mr. Cochran: Does your Honor wish to have this case argued?

The Court: No, I think I can grasp it. You have made yourself clear in your opening statement and the examination and it is a question of going through these patents and seeing whether there is something new or whether the matter has already been covered by these other patents or by claims already allowed.

Mr. Kolisch: May I just suggest to your Honor, in addition to the suggestion that I made in connection with Claim 70 that Claim 72 may be modified by adding at the end, "the latter being substantially mid-way between zero and full exposure", making a similar addition to the end of Claim 76? We could then erase Claims 74 and 78.

Mr. Cochran: Your Honor, as I understand, there is no possibility of amendment of a case coming here before your Honor, or any changes in the claims.

I think the case of Lucky in the decision of the Court of Appeals here has definitely settled that. The claims must be taken as they come here, and not with any amendments.

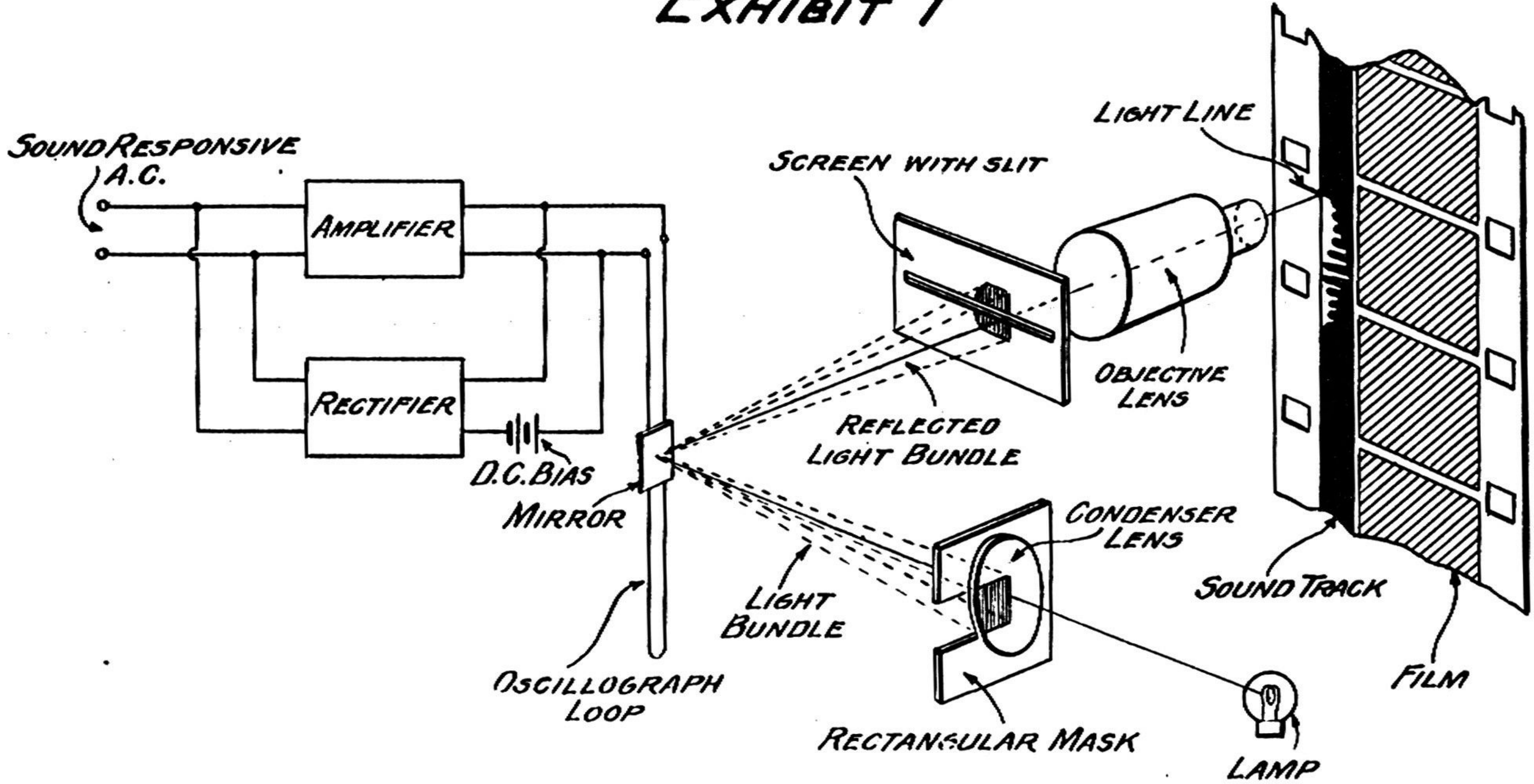
The Court: I think I will have to deny your application as to amendments which you suggest. The claims are very clearly set forth in the Bill of Complant.

Mr. Cochran: I think it has been very clearly stated as to that.

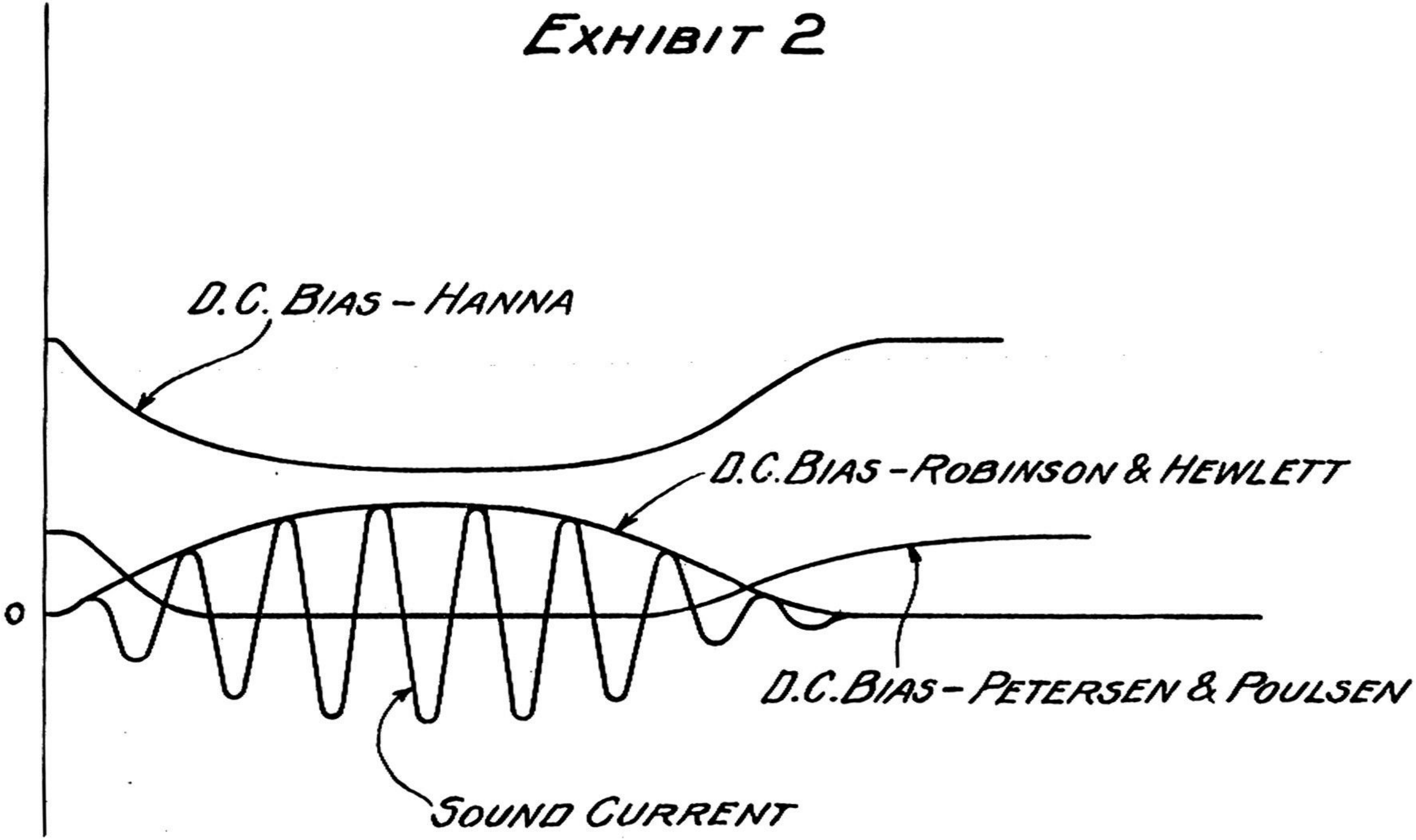
157 The Court: The Court will take it under advisement.

(Whereupon, at 2:30 o'clock p. m. the hearing in the foregoing cause was concluded, and the Court proceeded to the consideration of other business.)

EXHIBIT 1


SOUND RESPONSIVE A.C.
AMPLIFIER
RECTIFIER
D.C. BIAS
MIRROR
OSCILLOGRAPH LOOP
LIGHT BUNDLE
REFLECTED LIGHT BUNDLE
SCREEN WITH SLIT
OBJECTIVE LENS
CONDENSER LENS
RECTANGULAR MASK
LAMP
LIGHT LINE
SOUND TRACK
FILM

# EXHIBIT 2


D.C. BIAS – HANNA
D.C. BIAS – ROBINSON & HEWLETT
0
D.C. BIAS – PETERSEN & POULSEN
SOUND CURRENT

## EXHIBIT 3

Fig. a. *normal sound track (variable area)*

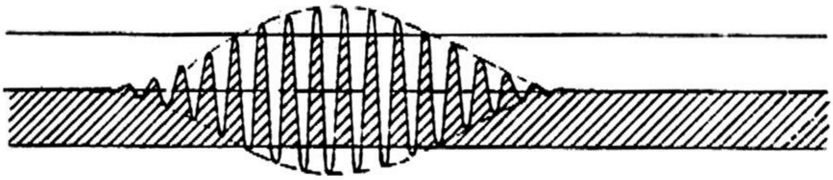


Fig. b. *sound track of Hanna*

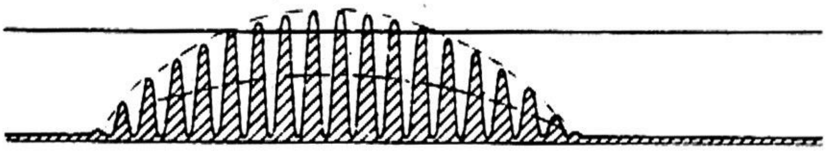


Fig. c. *sound track of Robinson and Hewlett.*

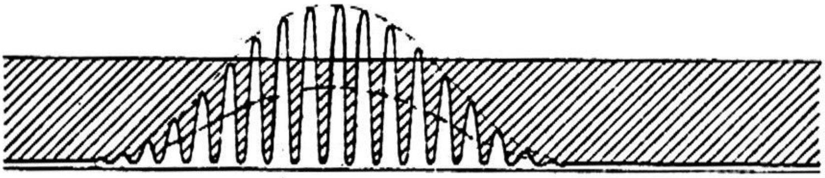
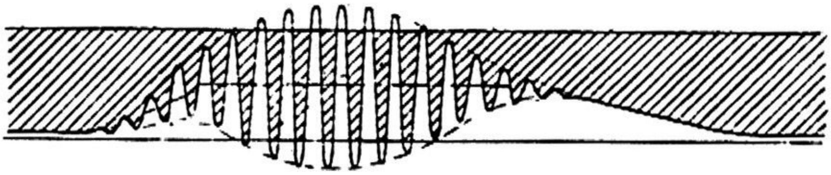


Fig. d. *sound track of Petersen and Poulsen.*



161

## *Findings of Fact*

### Filed February 14, 1939

1. This is a suit brought under the provisions of section 4915 R. S. (U. S. C., Title 35, Sec. 63), to have the Commissioner of Patents authorized to issue to plaintiffs a patent on their application, Serial No. 563,447, filed December 17, 1931, and containing claims 49, 70, 72, 73, 74, 76, 77, 78 and 79, as set forth in paragraph 7 of the Bill of Complaint.

2. Plaintiff's apparatus in suit is a system of photographically recording sound on the sound track of a motion picture film. The apparatus includes a source of light and an oscillograph for controlling the light flux. The oscillograph is in turn controlled by sound modulated alternating current means to expose the film in accordance with the amplitudes of the individual sound waves.

(a) The oscillograph is by an initial mechanical adjustment moved to a position in which it will expose half of the width of the sound track when no current is flowing through the oscillograph.

(b) The apparatus also includes a source of direct current connected to the oscillograph to bias it to a position in which it will expose to the light substantially no part of the sound track when no sound is being recorded.

(c) The apparatus further includes means for applying a portion of the sound modulated alternating current through a thermionic rectifier to the oscillograph to produce a variable bias in opposition to the said constant bias so as to reduce it substantially to zero as the sound volume increases from zero to a predetermined maximum.

162 (d) It is therefore a characteristic feature of plaintiffs' apparatus that the zero position of the oscillograph about which it oscillates is moved to said initial position when the sound reaches said predetermined maximum and maintains this position even if the sound volume increases above said maximum value. Consequently the cut-off of sound amplitudes exceeding this value will be symmetrical and harmful distortion will be avoided.

(e) Plaintiffs' system will produce a negative sound record in which the average exposure varies between a lower limit which is substantially zero, and an upper limit which is substantially midway between zero and full exposure.

(f) A further feature of plaintiffs' apparatus is the provision of a filtering circuit consisting of a condenser and a resistance inserted in the rectifier circuit for the purpose of smoothing the rectified current and for determining the rate of increase and decrease of the above mentioned variable bias; the value of the said resistance being so related to the resistance of the rectifier that the charging of the condenser during the passage of a positive half wave through the rectifier will be effected more quickly than the subsequent discharge of the condenser during the occurrence of a negative half wave.

(g) Still a further feature is the provision of means inserted in the circuit containing the above mentioned source of direct current bias solely for the purpose of preventing current of audio-frequency from affecting the oscillograph. These additional means consist of a resistance on each side of the oscillograph and a condenser connected across the resistances and the oscillograph.

3. The patent to Hewlett, No. 1,853,812, discloses an apparatus for photographically recording sound on a motion picture film by means of an oscillograph which is operated by an alternating current modulated in accordance with the sound.

163 (a) The oscillograph is, by an initial mechanical adjustment, biased to a position in which it will expose substantially no part of the sound track to the light during silent periods.

(b) The apparatus includes means for applying to the oscillograph a rectified portion of the alternating current to produce a variable bias which moves the oscillograph in accordance with the volume of the sound and in opposition to the initial mechanical bias thereof.

(c) The patent discloses a source of direct current connected to the oscillograph, but its biasing effect is nullified by another source of direct current provided specifically for that purpose.

(d) The patent does not disclose any means for limiting the average exposure of the sound record to any given proportion of its entire width.

(e) In the circuit from the rectifier to the oscillograph there are resistances and a condenser constituting together a filter which eliminates from the rectified current, variations of audio-frequency.

4. The Robinson patent No. 1,854,159, discloses an apparatus for photographically recording sound on a motion picture film in which an oscillograph operated by an alternating current modulated in accordance with the sound produces on the film a negative record of the sound. In order that the positive print made from the negative may be substantially completely blackened during silent periods the oscillograph is mechanically adjusted or biased to a zero or idle position when no sound is being recorded, such that it will expose substantially none of the film to the light. A portion of the alternating current is rectified and filtered to remove variations of audio-frequency and impressed on the modulated alternating current to move the zero position of the oscillograph in accordance with the volume of the sound.

164 (a) The patent does not contain a source of direct current for initially biasing the oscillograph.

(b) The patent does not disclose any means for limiting the average exposure of the sound record to any given proportion of its entire width.

5. The Hanna patent No. 1,888,724 discloses an apparatus for photographically recording sound on a motion picture film, in which an oscillograph is primarily operated by a portion of the sound modulated alternating current and in which another portion of the alternating current is rectified and filtered to eliminate variations of audio-frequency and then impressed on the amplifier, amplifying the first mentioned portion of the alternating current, for the purpose of amplifying weak sound more than strong sounds.

(a) In addition, this rectified and filtered portion of the alternating current is impressed on the oscillograph so as to move its zero position in accordance with the volume of the sound as recorded.

(b) The initial position of the oscillograph is biased by mechanical and electrical means so as to expose substantially the whole width of the sound track during silent periods when a negative record is being recorded, or alternatively to expose substantially none of the sound track when a positive record is being made.

(c) The purpose of varying the average exposure of the film is to correct, during reproduction, the distortion resulting from the above mentioned variable amplification during recording.

## *Conclusions of Law*

1. It was not invention to substitute means for limiting the average exposure of the sound record between a minimum of zero and a maximum midway between zero and full exposure for the mechanical and electrical biasing means disclosed in each of the patents, Hewlett No. 1,853,812 and Robinson 1,854,159.

165 2. The means disclosed in the Hewlett patent No. 1,853,812, the Robinson patent No. 1,854,159, and the Hanna patent No. 1,888,724, for filtering the rectified portion of the alternating current to remove variations of audio-frequency are each the patentable equivalent of the resistances and condenser set forth in plaintiffs' claim No. 49.

3. It was not invention to substitute means consisting of two resistances in series with the oscillograph and a condenser in parallel to the resistances and the oscillograph, as claimed in plaintiffs' claim 49, for the means disclosed in the Hewlett patent No. 1,853,812, the Robinson patent No. 1,854,159, and the Hanna patent No. 1,888,724, for filtering the rectified portion of the alternating current.

4. It was not invention to substitute means employing a direct current for biasing the oscillograph to a zero position near one edge of the sound track, as set forth in plaintiffs' claim 79, for the mechanical biasing means disclosed in each of the patents, Hewlett No. 1,853,812, and Robinson No. 1,854,159.

5. None of the plaintiffs' claims 49, 72, 73, 74, 76, 77, 78 and 79 distinguishes patentably from any one of the patents, Hewlett No. 1,853,812, Robinson No. 1,854,159 or Hanna No. 1,888,724.

6. Plaintiffs' claim 70 does not meet the requirements of Section 4888 of the Revised Statutes.

7. Plaintiffs are not entitled to a patent containing the claims in suit or any of them.

8. The Bill should be dismissed.

Feb. 14-1939

DANIEL W. O'DONOGHUE
*Justice*

---

166 *Final Judgment*

Filed Feb. 14, 1939

This cause having come on to be heard and having been tried in open court and argued by counsel for the respective parties upon the pleadings and proofs adduced and submitted to the Court,

It is ADJUDGED, this 14th day of February, 1939, that the Bill of Complaint in this case be, and the same hereby is dismissed with costs against the plaintiffs.

DANIEL W. O'DONOGHUE
*Justice*

Approved as to Form:
RALPH B. STEWART
*Attorney for Plaintiffs*

---

167 *Notice of Appeal*

Filed March 3-1939

* * *

Notice is hereby given that Arnold Poulson and Axel Carl Georg Petersen, plaintiffs above named, hereby appeal to the United States Court of Appeals for the District of Columbia from the final judgment entered in this action on February 14, 1939.

RALPH B. STEWART
*Attorney for Appellants Poulsen and Petersen.*

Washington, D. C.
March 3, 1939.

*Memorandum*

MARCH 3-1939.

Bond on Appeal for $250.00—filed.

---

168 *Points to be Relied Upon on Appeal*

Filed March 23 1939

* * *

Now comes Arnold Poulsen and Axel Carl Georg Petersen, the appellants in the above entitled cause, and by their attorney, state that the following are the points to be relied upon in their appeal, to wit:

1. The Court erred in holding that it was not invention to substitute means for limiting the average exposure of the sound record between a minimum of zero and a maximum midway between zero and full exposure for the mechanical and electrical biasing means disclosed in each of the patents, Hewlett No. 1,853,812 and Robinson 1,854,159.

2. The Court erred in holding that the means disclosed in the Hewlett patent No. 1,853,812, the Robinson patent No. 1,854,159, and the Hanna patent No. 1,888,724, for filtering the rectified portion of the alternating current to remove variations of audio-frequency are each the patentable equivalent of the resistances and condenser set forth in plaintiffs' claim No. 49.

3. The Court erred in holding that it was not invention to substitute means consisting of two resistances in series with the oscillograph and a condenser in parallel to the resistances and the oscillograph, as claimed in plaintiffs' claim 49, for the means disclosed in the Hewlett patent No. 1,853,812, the Robinson patent No. 1,854,159, and the Hanna patent No. 1,888,724, for filtering the rectified portion of the alternating current. 169

4. The Court erred in holding that it was not invention to substitute means employing a direct current for biasing the oscillograph to a zero position near one edge of the sound track, as set forth in plaintiffs' claim 79, for the mechanical biasing means disclosed in each of the patents, Hewlett No. 1,853,812, and Robinson No. 1,854,159.

5. The Court erred in holding that none of the plaintiffs' claims 49, 72, 73, 74, 76, 77, 78 and 79 distinguishes patentable from any one of the patents, Hewlett No. 1,853,812, Robinson No. 1,854,159 or Hanna No. 1,888,724.

6. The Court erred in holding that plaintiffs' claim 70 does not meet the requirements of Section 4888 of the Revised Statutes.

7. The Court erred in holding that plaintiffs are not entitled to a patent containing the claims in suit or any of them.

8. The Court erred in dismissing the Bill of Complaint.

9. The Court erred in not issuing a judgment authorizing the issuance of a patent to the plaintiffs containing the claims in suit or any of them.

RALPH B. STEWART
*Attorney for Plaintiffs.*

Washington, D. C.
March 23, 1939.

170 *Designation of Record on Appeal*

Filed March 23 1939

* * *

Now comes Arnold Poulsen and Axel Carl Georg Petersen, the appellants in the above entitled cause, and designate the parts of the record which they desire to have included in the Transcript, said parts being considered sufficient for the determination of the questions raised on appeal, namely:

1. Bill of Complaint
2. Answer
3. Condensation of file wrapper and attached stipulation.
4. Testimony
5. Plaintiffs' Exhibits 1, 2 and 3
6. Findings of Fact and Conclusions of Law
7. Final Judgment
8. Notice of Appeal
9. Memorandum of Appeal Bond.
10. Statement of Points Relied on in Appeal
11. Copy of this Designation of Record and Attached Stipulation
12. Clerk's Certificate.

171 It is requested that the above parts of record be included in the Transcript in the order in which they are listed.

RALPH B. STEWART
*Attorney for Plaintiffs.*

*Stipulation*

It is hereby stipulated and agreed by and between the parties hereto, through their respective attorneys, that the Transcript on appeal shall constitute those parts of the original proceedings as are set forth in the designation of record to which this stipulation is appended.

RALPH B. STEWART
*Attorney for Plaintiffs*

W. W. COCHRAN
*Attorney for Defendant.*

Washington, D. C.
March 23, 1939.

172 *Stipulation*

Filed March 28 1939

* * *

It is hereby stipulated by and between the attorneys for the respective parties in the above entitled cause that the opening statements of the respective attorneys shall be omitted from the transcript of record on appeal.

RALPH B. STEWART
*Attorney for Plaintiffs.*

W. W. COCHRAN
*Attorney for Defendant.*

Washington, D. C.
March 28, 1939.

173

## District Court of the United States for the District of Columbia

UNITED STATES OF AMERICA,
*District of Columbia, ss:*

I, Charles E. Stewart, Clerk of the District Court of the United States for the District of Columbia, hereby certify the foregoing pages numbered from 1 to 172, both inclusive, to be a true and correct transcript of the record, according to directions of counsel herein filed, copy of which is made part of this transcript, in cause No. 64497 in Equity, wherein Arnold Poulsen and Axel Carl Georg Petersen are Plaintiffs and Conway P. Coe, Commissioner of Patents, is Defendant, as the same remains upon the files and of record in said Court.

IN TESTIMONY WHEREOF, I hereunto subscribe my name and affix the seal of said Court, at the City of Washington, in said District, this 3rd day of April, 1939.

C. E. STEWART,
(Seal) *Clerk.*

Endorsed on Cover: No. 7380. Poulsen et al., Appellants, vs. Coe. United States Court of Appeals for the District of Columbia Filed Apr 4-1939 Joseph W. Stewart, Clerk

IN THE

# United States Court of Appeals for the District of Columbia

Arnold Poulsen and Axel Carl Georg Petersen,
*Appellants,*
*vs.*
Conway P. Coe, Commissioner of Patents,
*Appellee.*

**April Term, 1939**
**No. 7380**

## BRIEF FOR APPELLANTS.

Paul Kolisch,
*Attorney for Appellants.*

Lawyers Press, Inc., 165 William Street, New York City, N. Y.

# INDEX

PAGE

Statement of the Case 1

Errors Relied Upon 2

The Points of Law and Fact To Be Discussed 2

I. The Prior Art Background of the Invention 3
- (1) The Recording System 3
- (2) The Normal Sound Track 4
- (3) The "Silent" Recording of Robinson and Hewlett 5
  - (a) The Robinson and Hewlett Recording System 6
  - (b) The Robinson and Hewlett "Silent" Record 6
- (4) Prior Art Recording System Introduced Objectionable Distortion in Sound Recording 7

II. Appellants' Invention 7
- (1) Appellants' Solution of the Problem 9

III. The Prior Patents Cited 11
- (1) Hanna, No. 1,888,724 (71) 11
- (2) The Claims of the Prior Patents Are Incompatible with the Invention in Issue 12
- (3) The Differences Between the Disclosures of Appellants and of the Prior Art 12
  - (a) Initial positioning of the oscillograph 13

PAGE

(b) D.c. bias ..... 14

(c) Limits of zero line displacement—peak cut-off ..... 14

(d) Limits of average exposure dependent on limits of zero line displacement ..... 16

IV. The Claims ..... 16

V. Commercial Success ..... 22

Conclusion ..... 23

## Cases Cited.

Cambridge Trust Co., et al. v. Coe, 87 F. (2d) 543, 545 ..... 22

Kelley v. Coe, 39 U. S. P. Q. 57, 63 ..... 8

Van Heusen Products, Inc. v. Earl & Wilson, 300 Fed. 922, 929 ..... 10

Wach v. Coe, 64 Ap. D. C. 235; 77 F. (2d) 113 ..... 22

H. C. White Co. v. Morton E. Converse, 20 Fed. (2d) 311, 313 ..... 10

IN THE

# United States Court of Appeals for the District of Columbia

ARNOLD POULSEN and AXEL CARL GEORG PETERSEN,
*Appellants,*
*vs.*
CONWAY P. COE, Commissioner of Patents,
*Appellee.*

**April Term, 1939**
**No. 7380**

## BRIEF FOR APPELLANTS.

### Statement of the Case.

This is an appeal from a decision of the District Court for the District of Columbia (Justice O'DONOGHUE) dismissing the Bill of Complaint in a suit brought under the provisions of Section 4915 (U. S. C., Title 35, Sec. 63), to authorize the Commissioner of Patents to issue to plaintiffs-appellants a patent on their application for Letters Patent Serial No. 563,447, filed December 17, 1931, with claims 49, 70, 72, 73, 74, 76, 77, 78 and 79.

The Commissioner of Patents alleged and the District Court found no anticipation but held eight of these claims invalid as lacking in invention over certain prior art, and claim 70 as failing to meet the requirements of Section 4888 of the Revised Statute.

## Errors Relied Upon.

Appellants rely on every one of the errors pointed out in the appeal (124),* *i. e.*, that the District Court erred in holding the claims as lacking in patentable invention over the prior patents to Robinson, Hewlett and Hanna, and that one of the claims (No. 70) fails to meet the requirements of the statute.

## The Points of Law and Fact To Be Discussed.

The invention covered by the claims in issue is for an improved method and system of recording sound on films such as are used in the making of talking motion pictures. Appellants' novel method and system have never been disclosed by anyone and are not only different from but antithetic to the disclosures of the three references on which the Commissioner relies (Robinson, Hewlett and Hanna). The prior art had not even recognized the existence of the problem which appellants had solved.

In order to show the erroneousness of the conclusions reached by the District Court, we shall analyze the facts and the law applicable thereto under the following headings:

I. The prior art background of the invention.
  (1) The recording system.
  (2) The normal sound track.
  (3) The "silent" recording of Robinson and Hewlett.
    (a) The Robinson and Hewlett recording system.
    (b) The Robinson and Hewlett "silent" record.

---

* The numerals in brackets refer to page numbers in the printed record.

(4) The prior art recording system introduced objectionable distortion in sound recording.

II. Appellants' invention.

(1) Appellants' solution of the problem.

III. The prior patents cited.

(1) Hanna No. 1,888,724.

(2) The claims of the prior patents are incompatible with the invention in issue.

(3) The differences between the disclosures of appellants and of the prior art.

IV. The claims.

V. Commercial success.

## I. The Prior Art Background of the Invention.

### (1) The Recording System.

In the typical sound recording system as illustrated in Exhibit 1 (116), the microphone which intercepts the sounds produces a sound-responsive alternating current indicated in the left-hand corner. This current is amplified and will, depending on its magnitude, cause an oscillograph loop and associated mirror to oscillate.

Light from a lamp is condensed by a lens equipped with a mask into a bundle which impinges on the mirror and is reflected by it. The light bundle is reflected by the mirror on a horizontal slit of a screen. The light spot on the screen as indicated in Exhibit 1 is the shaded area. As the mirror oscillates, *i. e.*, as the sound varies, the light spot will move back and forth along the slit.

That portion of the reflected light bundle which is not blocked by the screen, *i. e.*, the thin, short bar which passes through the slit, is focused by means of an objective lens on the film as a short, fine line of light. The film is continuously traveling in a downward direction and, on account of the oscillations of the mirror, the light line will move back and forth transversely to the travel of the film, and trace on it a track with a jagged contour which represents the sound.

For the sake of simplicity, only the positive sound record is shown in Exhibit 1. In the negative the white and black portions of the sound track will be reversed. The white edge of the film where the sprocket holes are indicated and the strip between the sound track and the picture frames are protected against exposure by the light line, so that the sound track will have sharp, straight, margins. In order to save material, the sound record is customarily on the same film as the pictures and is, therefore, restricted to a narrow band.

### (2) The Normal Sound Track.

The sound track thus produced is illustrated in Fig. *a* of Exhibit 3 (118).

The sound track can be audibly reproduced by moving it past a fine light line, more or less of which shines on a photoelectric cell, depending on the extent to which the track is blackened (exposed). A loud speaker is operated under the control of the photoelectric cell.

It will be noted that this sound record is symmetrical with respect to the horizontal center line or axis which is usually referred to as the "zero line". The recording system illustrated in Exhibit 1 (116) is so adjusted that normally all the undulations will fall within the two boundaries of the track. When, however, sounds of great amplitude are produced, then the swing of the mirror will be so great that the peaks of the sound trace will fall outside of the track margins. The peaks will not be reproduced on the positive track. In Fig. *a* of Exhibit 3, the seven central peaks which are indicated beyond the upper and lower boundary lines of the track will thus be cut off.

While such mutilation of the sound record is not desirable, one does not notice it in listening to the reproduction of such film because the sound trace is symmetrical, *i. e.*, the same amount is cut off the tops as off the bottoms of the undulations. A sound track wide enough to take care of these extra loud sounds could not be accommodated on the margin of the picture film.

When in such tracks no sounds or sounds of low amplitudes were recorded, then a large area of the film, up to one-half the track width, was covered by the light line (Exhibit 1), and the corresponding part remained transparent (unexposed) on the positive film. Scratches and specks of dust on the unexposed, transparent portions of the film actuate the sound reproducing apparatus in the same manner as sound records, giving rise during what should be the silent periods, to crackling, hissing noises, generally referred to as "background noise" (80).

### (3) The "Silent" Recording of Robinson and Hewlett.

This background noise was eliminated or minimized by producing the record illustrated in the Hewlett Patent No. 1,853,812 (60), and the Robinson Patent No. 1,854,159 (65). Hewlett and Robinson were outstanding inventors in this art employed by the General Electric Company (p. 80, fol. 96 p. 100, fol. 131), and as we shall show later, their efforts and those of Hanna (the third patent on which the Commissioner is relying), represent the highest development of the prior art at the time appellants entered the field.

### (a) *The Robinson and Hewlett Recording System.*

Both Hewlett and Robinson connected a rectifier in parallel with the amplifier (Exhibit 1, p. 116) to oscillate the mirror not only in accordance with the amplitude of the sounds, but also in accordance with a rectified component of the sound-responsive alternating current. In making the record shown in Fig. *a* of Exhibit 3, the recording equipment was so adjusted that during silence the right-hand end of the light line (Exhibit 1, p. 116) fell on the center, the axis of the sound track, whereby when no sounds or low amplitude sounds were recorded, half of the track remained unexposed (p. 79, bottom paragraph). As distinguished from this, in the Robinson and Hewlett arrangement, during the silent period the right-hand end of the light line fell on or near the left-hand edge of the track. As the amplitude of the sounds increased, the zero line about which the light line was oscillated, was displaced towards the opposite edge of the sound track (p. 81, top paragraph).

### (b) *The Robinson and Hewlett "Silent" Record.*

In the record that was thus produced the zero line is not a straight line down the center of the sound track but, as shown in Fig. *c*, Exhibit 3 (118), a wavy line, the position of which varies with sound amplitude. In the positive record, during the silent period and while low amplitude sounds are recorded, only a very small part of the sound track will remain unexposed, the upper part being completely blackened. It does not matter that the transparent portion increases as the sound amplitude increases, because background noise is troublesome only during silent periods; loud sounds will drown it out.

### (4) Prior Art Recording System Introduced Objectionable Distortion in Sound Recording.

While the Robinson and Hewlett scheme solved the background noise problem, it introduced a harmful distortion owing to the asymmetrical cut-off of large amplitude sounds. As distinguished from Fig. *a* of Exhibit 3 (118) where the peaks of the loudest sounds are symmetrically cut-off on both sides of the record, in Robinson and Hewlett, Fig. *c*, Exhibit 3 (118), the peaks will be cut off on only one side of the sound track. Assuming the same amplitudes, in Fig. *c* the cut-off at the upper edge will be twice as much as in Fig. *a* (118), and as Mr. Poulsen said (83):

> "Now, this asymmetrical cut-off is causing a very harmful distortion which can be heard. So at the same time as this reduction of the background noise was obtained a rather harmful effect of distortion was introduced."

At the bottom of page 83 and top of page 84 Mr. Poulsen explained why the Robinson and Hewlett arrangement introduced this distortion and why in the systems and methods disclosed in their patents it was impossible to avoid the asymmetric cut-off.

## II. Appellants' Invention.

The method and system of appellants will produce the record shown in Fig. *d* of Exhibit 3 (118) which has all the advantages and none of the disadvantages of the records Fig. *a* and Fig. *c* of Exhibit 3. This they accomplished without increasing the cost of recording and without materially altering the construction and arrangement of the recording apparatus; they accomplished it by a change in the system and method of adjusting and operating the otherwise well-known recording equipment and without increasing the cost of installation and operation. This is one of those rare inventions to which one may apply the language of this Court in *Kelley* v. *Coe* (39 U. S. P. Q. 57, 63):

> "The fact that Kelley's method may seem simple in its operation does not disprove invention.* The difference between it and the prior art may not be great in a physical sense, but slight as it may seem to be it was sufficient to achieve success where success had never before been achieved."

The footnote to this passage is as follows:

> "United Shoe Machinery Corp. v. Ferree Co., 2 Cir., 64 F(2d) 101 (17 USPQ 402), cert.. dismissed, 290 U. S. 708. In Potts v. Creager, 155 U. S. 597, 608, the court said: 'The apparent simplicity of a new device often leads an inexperienced person to think that it would have occurred to anyone familiar with the subject; but the decisive answer is that with dozens and perhaps hundreds of others laboring in the same field, it had never occurred to anyone before. The practised eye of an ordinary mechanic may be safely trusted to see what ought to be apparent to everyone.' In Loom Co. v. Higgins, 105 U. S. 580, 591, the court said: '* * * it is plain from the evidence, and from the very fact that it was not sooner adopted and used, that it did not, for years, occur in this light to even the most skilful persons. It may have been under their very eyes, they may almost be said to have stumbled over it; but they certainly failed to see it, to estimate its value, and to bring it into notice. * * * Now that it has succeeded, it may seem very plain to anyone that he could have done it as well. This is often the case with inventions of the greatest merit.' See, also, Expanded Metal Co. v. Bradford, 214 U. S. 366, 381; Krementz v. S. Cottle Co., 148 U. S. 556, 560; De Bois v. Kirk, 158 U. S.

> 58, 63; General Electric Co. v. Hill-Wright Electric Co., 2 Cir. 174 F. 996, 998; Brick v. Namm & Sons, E. D. N. Y., 22 F(2d) 693, 695, aff'd. 2 Cir., 22 F(2d) 697."

### (1) Appellants' Solution of the Problem.

Appellants use the same recording arrangement as Robinson and Hewlett. From the broadest aspect of the invention there is only a slight difference in the adjustment of the recording circuit. The prior inventors placed only one limit (the edge of the track) to the displacement of the zero line and permitted it to rise to any extent with the amplitude of the sound. Appellants adjust the circuit so that there are two definite limits to the displacement of the zero line; (1) the edge of the sound track, and (2) the center of the sound track.

However, this small change made an enormous difference in the result. The asymmetric cut-off of very loud sounds is eliminated because, as will be seen from Fig. *d* of Exhibit 3, the zero line cannot rise beyond the middle of the track. The advantages of the Robinson "silent" recording are retained, because during silent periods the zero line will be near the lower edge of the track. In other words, very loud sounds will be recorded in the same manner as in the normal system (Fig. *a*, Exhibit 3), and all other sounds as in the "silent" system (Fig. *c*, Exhibit 3).

Referring now to Exhibit 1 (116), appellants retain the prior recording system but, as Mr. Poulsen stated (87):

> "We introduced in series with the rectifier a constant d.c. bias, represented in the figure by a battery, and we adjusted the connections in such a way that the variable bias produced by the rectifier would oppose the contant d.c. bias, so as to reduce the constant d.c. bias the greater the sound amplitudes are. At the

> same time we adjusted our oscillograph in a different way, whereas Robinson and Hewlett adjusted the oscillograph so that when it was currentless, when there was no current in it, the edge of the light line would be close to the edge of the track, and we adjusted the oscillograph so that when there was no current in it the end of the light line will be at the center of the track."

As Mr. Poulsen described in the next paragraph on page 87, the constant d.c. bias was introduced to move the light line from this normal position at the center of the track to the edge of the track during the silent periods. As the amplitude of the sound increases, the constant d.c. bias is diminished so as to permit the zero line, *i. e.*, the edge of the line of light, to move back to its original position along the center of the track. The zero line could never pass beyond the center line nor beyond the edge of the track.

The District Court found that appellants' method and system will produce a record in which

> "harmful distortion will be avoided" ((2$^d$), p. 119).

Poulsen testified (88, fol. 109) that none of the prior references cited produces this result, none recognizes the necessity or desirability of producing this result, and none discloses instrumentalities by means of which the result could be produced.

Approaching the question of patentability in view of the preceding history of the art and testing the invention against that background, the conclusion is inescapable that we are here dealing with an invention of great merit (*Van Heusen Products, Inc.* v. *Earl & Wilson,* 300 Fed. 922, 929; *H. C. White Co.* v. *Morton E. Converse,* 20 Fed. (2d) 311, 313).

## III. The Prior Patents Cited.

We have already discussed the Robinson and the Hewlett patents. Although, as Poulsen testified (p. 85, fol. 104), all three prior patents relied upon have the same shortcoming as to asymmetric cut-off, we shall briefly refer to the third prior patent on which the findings of the District Court were based.

### (1) Hanna, No. 1,888,724 (71).

Hanna's sound track is illustrated in Fig. *b,* Exhibit 3 (118). It is substantially the reverse of the Robinson, Hewlett track (Fig. *c*), or, if we take the negative of the Hanna track, then it is substantially identical with the Robinson and Hewlett positive track (Poulsen, top of p. 85, p. 104, fol. 138, p. 105, fol. 139).

In Hanna the peaks were asymmetrically cut off as in Robinson and Hewlett, and the lower edges of the peaks were on a straight line. In neither Hewlett nor Robinson, nor Hanna, was there an upper limit to the displacement of the zero line (p. 90, fol. 113). As a matter of fact, Hanna's patent had nothing to do with silent recording of the type in which we are here interested. Hanna's patent had to do with a system like that of the Sacia Patent No. 1,623,756 (p. 53) which was cited in the Answer, but which the Commissioner withdrew during the trial (101). As distinguished from appellants' purpose of producing an unmutilated silent record, the Court found that Hanna's purpose was ((c), p. 122):

> "to correct, during reproduction, the distortion resulting from the above mentioned variable amplification during recording."

### (2) The Claims of the Prior Patents Are Incompatible with the Invention in Issue.

The claims of the Robinson patent (p. 69) specify that the peaks must extend to the side of the track irrespective of variations in the volume (claim 4) and that the axis of the record must recede in accordance with the volume of the sound (claims 5, 6, 7, 10). As Mr. Poulsen testified, this means that the record must be as shown in Fig. *c* of Exhibit 3 (pp. 93, 94).

Hewlett also claims (pp. 63, 64) that the zero line is varied in accordance with the peak values (claims 1, 2, 3) and further, that the influence of the battery (source of d.c. bias) must be balanced out in the biasing circuit (claim 5) (Poulsen, p. 100), the antithesis of the Poulsen and Petersen invention.

Hanna emphasizes in his claims (p. 76) that the tops of the peaks must have a substantially common level (claims 6, 7), and that the zero line should be varied in accordance with amplitude (claim 9).

It is not reasonable to assume in the face of this that one skilled in the art would go counter to the express language and showing of these patents, limit the displacement of the zero line between predetermined limits irrespective of the volume to which the sound may rise, permit the peaks to form along an irregular rather than a straight line or common level, and deliberately introduce a source of unidirectional or direct current in the biasing circuit.

### (3) The Differences Between the Disclosures of Appellants and of the Prior Art.

These can best be shown by comparing the various findings of the District Court.

(a) *Initial positioning of the oscillograph.*

The District Court found ((2$^{a}$), p. 119), that in appellants' structure—

> "the oscillograph is by an initial mechanical adjustment moved to a position in which it will *expose half** *of the width of the sound track* when no current is flowing through the oscillograph."

As distinguished from this, in the Hewlett patent (Finding (3$^{a}$), p. 120):

> "The oscillograph is, by an initial mechanical adjustment, biased to a position in which it will *expose substantially no part of the sound track* to the light during silent periods."

In Robinson (Finding (4), p. 121):

> "The oscillograph is mechanically adjusted or biased to a zero or idle position when no sound is being recorded, such that it will *expose substantially none of the film* to the light."

In Hanna (Finding (5$^{b}$), p. 121):

> "The initial position of the oscillograph is biased by mechanical and electrical means so as to *expose substantially the whole width of the sound track* during silent periods when a negative record is being recorded, or alternatively to expose substantially none of the sound track when a positive record is being made."

---

* Emphasis ours throughout the brief.

(b) *D.c. bias.*

In the Poulsen and Petersen system, in accordance with the Finding ($2^b$), (p. 119):

> "The apparatus also includes *a source of direct current* connected to the oscillograph *to bias* it to a position in which it will expose to the light substantially no part of the sound track when no sound is being recorded."

As distinguished from this, in Hewlett (Finding ($3^c$), p. 120):

> "The patent discloses *a source of direct current* connected to the oscillograph, *but its biasing effect is nullified* by another source of direct current provided specifically for that purpose."

As to Robinson (Finding ($4^a$), p. 121), the patent does *not* contain a source of direct current for initially biasing the oscillograph.

(c) *Limits of zero line displacement—peak cut-off.*

The Finding as to the instrumentalities employed by Poulsen and Petersen is (p. 119):

> "(c) The apparatus further includes means for applying a portion of the sound modulated alternating current through a thermionic rectifier to the oscillograph to produce a variable bias in opposition to the said constant bias so as to reduce it substantially to zero as the sound volume increases from zero to a predetermined maximum.
>
> (d) It is therefore a characteristic feature of plaintiff's apparatus that the zero position of the oscillograph about which it oscillates is moved to said *initial position* when the sound reaches said predeter-

> mined maximum and *maintains this position even if the sound volume increases above said maximum value.* Consequently the *cut-off* of sound amplitudes exceeding this value will be symmetrical and harmful distortion will be avoided."

Therefore, in appellants' system the zero line is not always displaced in accordance with the volume of the sound but only up to a certain point (the center line), and then shifts no further no matter to what extent the volume of the sound may increase.

As distinguished from this there is no finding that any of the prior patents avoids harmful distortion caused by asymmetrical cut-off and, as distinguished from the instrumentalities that appellants have, the Court found that in Hewlett ((3b) p. 120):

> "The apparatus includes means for applying to the oscillograph a rectified portion of the alternating current to produce a variable bias *which moves the oscillograph in accordance with the volume of the sound* and in opposition to the initial mechanical bias thereof."

In Robinson (Finding (4), p. 121):

> "A portion of the alternating current is rectified and filtered to remove variations of audio frequency and impress on the modulated alternating current to *move the zero position of the oscillograph in accordance with the volume of the sound.*"

In Hanna (Finding (5a), p. 121):

> "(a) In addition, this rectified and filtered portion of the alternating current is impressed on the oscillograph *so as to move its zero position in accordance with the volume of the sound* as recorded."

(d) *Limits of average exposure dependent on limits of zero line displacement.*

As to the results accomplished by these arrangements the Court found (Finding ($2^e$), p. 119):

> "Plaintiff's system will produce a negative sound record in which the average exposure varies between a *lower limit which is substantially zero,* and an *upper limit which is substantially midway between zero and full exposure.*"

This is merely another way of saying that the zero line is shifted between two limits; the edge and the middle of the sound track (p. 90, fol. 113).

In Hewlett (Finding ($3^d$), p. 120):

> "The patent does *not disclose any means for limiting* the average exposure of the sound record to any given portion of its entire width."

As to Robinson, the Court found (($4^b$), p. 121):

> "The patent does *not disclose any means for limiting* the average exposure of the sound record to any given portion of its entire width."

It is submitted that these findings should have led to the conclusion that the claims, which we shall presently discuss, define an invention of great merit which was not even approximated by the prior art.

## IV. The Claims.

In order to point out the improvement that appellants have achieved we shall quote the claims, italicizing the novel steps and means. First we shall quote the broadest claims:

"72. The method of producing a photographic sound record comprising the following steps: directing a light beam onto a moving film so that it receive a transversely disposed extremely narrow strip of light, variably exposing the film in accordance with the amplitude of each individual sound wave, controlling the light impinging on the film to vary the average exposure of the film as the volume of the sound to be recorded varies, and *holding the variations of the average exposure between predetermined lower and upper limits.*

73. The method according to claim 72 and in which the *lower limit* of the average exposure variation is approximately *zero.*

74. The method according to claim 72 and in which the *upper limit* of the average exposure variation is substantially *midway between zero and full exposure.*

76. In a photographic sound recording system including a moving film, a source of light and a light flux controlling element, sound modulated alternating current means for controlling said element to expose the film in accordance with the amplitude of each individual sound wave, and biasing means for controlling said element *to vary the average exposure of the film between a predetermined lower and a predetermined upper limit.*

77. The recording system according to claim 76 and in which the *lower limit is approximately zero.*

78. The recording system according to claim 76 and in which the *upper limit is substantially midway between zero and full exposure.*

79. The recording system according to claim 76 and in which *a source of unidirectional current applies a constant bias on said element,* and means for applying a rectified portion of the alternating current

> to *reduce the bias* substantially *to zero* as the sound volume increases from zero to *a predetermined maximum.*"

We believe that the meaning of these claims will be clear. Claim 79 adds as a limitation to claim 76 the definition of the d.c. bias which is added to the customary rectifier arrangement (see Exhibit 1, p. 116) to insure the predetermined upper and lower limits which is the characteristic feature of the invention.

Claim 49 defines specific details of appellants' arrangement. The claim is as follows:

> "49. An apparatus for producing a photographic sound record of the variable width type comprising means for directing a beam of light onto a moving film so as to form a transversely disposed narrow strip of light on the film, means actuated by a sound responsive current for varying the length of the strip of light in accordance with the amplitude of the sound, a thermionic tube arranged so that its plate current actuates light varying means, means for applying a biasing potential to the grid of said tube, means actuated by a rectified portion of the sound responsive current for controlling said biasing potential in accordance with the volume of the sound so as to cause the plate current of the tube to vary in accordance with the volume of the sound, *the apparatus being so adjusted that the zero line of the sound trace takes up such an initial position relatively to the sound track that, when the plate current attains a zero value, the zero line moves from the said initial position into the center line of the sound track,* said apparatus including an oscillograph for directing the beam of light onto the film and for swinging the beam in accordance with the amplitude of the sound, in which the loop of the moving system of the oscillograph is connected in the plate circuit of the thermi-

> onic tube *in series with two ohmic or inductive resistances, which are arranged one on each side of the loop, with a condenser connected across the said resistances and the loop, in order to prevent current of audible frequencies in the plate circuit from affecting the mean position of the moving system of the oscillograph.*"

Down to the first italicized passage the claim describes the well-known Robinson or Hewlett recording system. As to that passage, Mr. Poulsen said (p. 109, fol. 147):

> "This is in accordance with our invention, as I have explained several times before, and not in accordance with any of the specifications cited in the case, because none of these specifications have limits on the movement of the zero line, none of them could claim that the zero line moves from said initial position into the center line of the sound track."

The last italicized portion of the claim was explained by Mr. Poulsen as follows (p. 110):

> "This is a rather restricted claim, referring to certain details of our circuit, which are not to be found in any of the cited patents. It refers to Fig. 4, where in the plate circuit of tube *p* two resistances (*q*) are inserted in series with the oscillograph, and a condenser (*r*) is connected in parallel to the two resistances and the oscillograph.
>
> "The object of this arrangement is to eliminate from the oscillograph any trace of audible current which may have been left in the rectified current which is applied to the loop as a result of the rectification and the smoothing of that rectified current.
>
> "When you rectify a current, it will have a wavy curve. It is consisting of all the half waves, for instance, all the positive half waves, of the alternating current, and therefore, it will be a pulsating current.

> "Now, these variations would be audible if they were not smoothed out, and therefore a smoothing circuit is applied in connection with the rectifier, but there may be still some small traces of alternating current left, and it would be harmful to add them to the original alternating current in the oscillograph. If you did not eliminate them entirely, they would go into the record and produce some distortion, and therefore this arrangement has been added in order to entirely eliminate any trace of ripples in the rectified current."

Then on page 111 Mr. Poulsen explains the differences between this arrangement and the prior patents:

> "This is not found in any of the references cited in the case, and I believe there has been some misunderstanding in the Board of Appeals as to the object of this circuit.
>
> "Q. The resistances and the inductances and the capacities with which the prior patentees deal, will you state how these are connected or in what portions of their circuits they are connected? A. They are all forming part of the smoothing circuit in connection with the rectifier.
>
> "For instance, in the Robinson patent the inductances 40 in Fig. 1 are inserted in order to smooth out the ripples.
>
> "And in Hewlett's patent, resistances 36-38 and the condenser 37 are inserted in order to smooth out the ripples.
>
> "Also in Hanna an inductance 33 and condensers 34 are shown in the smoothing circuit, but they are all placed in the smoothing circuit.
>
> "Q. In the smoothing circuit of the rectifier? A. In the smoothing circuit, yes, and they are all affecting the time constant of the rectifying circuit.
>
> "Q. And will you state it again as distinguished from that, what your patent does? A. As distin-

> guished from ours, which are inserted in the plate circuit in which the oscillograph is inserted, *and are distinctly separate from the rectifying circuit.*"

No art has been cited against claim 70. It was objected to on the ground that it was not sufficiently definite to satisfy the statute. The claim is as follows:

> "70. A system for recording sounds on a light-sensitive film comprising means for converting sounds into an alternating current, a light source, means to concentrate a beam of light from said light source onto the surface of the film so as to form thereon a transversely disposed linear strip of light, means to cause the exposure of the film to vary in accordance with the alternating current, a rectifier rectifying a portion of said alternating current, and a smoothing circuit through which the rectified current influences said sound recording means to cause the exposure to vary dependent on the volume of sound, *the electrical constants of the rectifier and said smoothing circuit being so adjusted that the time constant of the total rectifying circuit is of smaller value when the rectifier is operative than when it is inoperative.*"

The italicized passage, which is concededly novel, means that the smoothing circuit is so adjusted that the time constant of the total rectifying circuit is of smaller value when the current is flowing through the rectifier than when no current is flowing through the rectifier (p. 109, fol. 146).

Mr. Poulsen testified (p. 108):

> "That expression that the rectifier is operative or inoperative was held vague and meaningless by the Examiner. But it is well understood by those skilled in the art that a rectifier is operative when a current is flowing through it and inoperative when no current is flowing through it."

There was no other evidence before the Court on which the conclusion could be based ((6), p. 122) that the claim does not meet the requirements of the statute.

Although claims have been allowed by the Patent Office in the Poulsen and Petersen application, they deal with other features and other inventions and none deals with the invention here in issue (top of p. 90).

## V. Commercial Success.

Appellants' system and method have gone into use throughout the world and patents have been granted thereon in most countries (103, 104). The Hanna scheme has never been used by anyone (p. 103, fol. 136).

Commercial success is a weak foundation for an argument in favor of patentability and we are advancing it in the present case mainly for the purpose of avoiding the impression that appellants' invention exists only on paper. As this Court said in *Cambridge Trust Co., et al.* v. *Coe* (87 F. (2d) 543, 545):

> "We are not impressed by the contention that the widespread commercial success and utility of this product is evidence of its patentability."

However, the facts of the present case seem to be analogous with the facts in *Wach* v. *Coe* (64 Ap. D. C. 235; 77 F. (2d) 113), where

> "the best marine engineers in the world with unlimited means at their command, failed to solve the problem, the solution of which the tribunals of the Patent Office and the Court below have ruled to be obvious to one skilled in the art."

## *Conclusion.*

***The decision of the District Court should be reversed and the cause remanded for the issuance of a decree in accordance with the prayer of the Bill of Complaint.***

Respectfully submitted,

PAUL KOLISCH,
*Attorney for Appellants.*

New York, August 22, 1939.

[illegible]

FILED SEP 18 1939

Joseph W. Stewart

CLERK

## No. 7380

---

# In the United States Court of Appeals for the District of Columbia

Arnold Poulsen and Axel Carl Georg Petersen,
APPELLANTS

*v.*

Conway P. Coe, Commissioner of Patents,
APPELLEE

*APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA*

## BRIEF FOR THE COMMISSIONER OF PATENTS

W. W. COCHRAN,
*Attorney for Commissioner of Patents, Appellee.*

# INDEX

Page

Introduction........................................ 1
Sound records on motion-picture film........................ 2
Position of the Patent Office on appellants' application....... 2
Appellants' application.................................. 3
The Hewlett and Robinson patents........................ 4
The claims on appeal................................... 5
Summary of argument................................... 6
Argument............................................. 6
Conclusion........................................... 8
Appendix (Section 4888 R. S.)............................ 9

# In the United States Court of Appeals for the District of Columbia

OCTOBER TERM, 1939

---

No. 7380

ARNOLD POULSEN AND AXEL CARL GEORG PETERSEN,
APPELLANTS
*v.*
CONWAY P. COE, COMMISSIONER OF PATENTS,
APPELLEE

---

*APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA*

---

## BRIEF FOR THE COMMISSIONER OF PATENTS

---

### INTRODUCTION

This is an appeal from the judgment of the District Court of the United States for the District of Columbia (R. p. 123) dismissing a complaint under Section 4915 R. S. (U. S. C., Title 35, Sec. 63) brought by appellants to authorize the Commissioner of Patents to issue to appellants a patent containing certain claims of their application No. 563,447, relating to the sound record of a motion-picture film.

## SOUND RECORDS ON MOTION-PICTURE FILM

The sound record of a motion-picture film is a narrow strip along the side of the series of pictures on said film. This strip, which is of a photographically sensitive material, is variably exposed to light, the variations of which correspond to the sound which is being recorded. When the film is developed the unexposed areas of the strip are transparent and the exposed areas are opaque. This results in the strip having a variable total transparency in accordance with the sound being recorded. It will be obvious that when the film is developed and printed on to a positive there will ordinarily be considerable areas of the sound track which are transparent. In the handling of such films considerable abrasions may occur, producing scratches and specks on the transparent areas which will when the sound is reproduced from the film, cause an annoying background noise. The end sought by appellants and by other and prior inventors is to avoid the background noise by eliminating as far as possible the transparent areas.

## POSITION OF THE PATENT OFFICE ON APPELLANTS' APPLICATION

The Patent Office recognized that certain features of appellants' apparatus and method involve invention over the prior art and allowed a number of claims which the Patent Office considered to define the invention properly and distinguish from the prior art. The Patent Office, however, rejected the claims on appeal on the ground that they do not meet these requirements and the lower court upheld the rejection.

## APPELLANTS' APPLICATION

The structure and operation of appellants' device is well shown diagrammatically in their Exhibit 1 (R. p. 116) and has been properly described in appellants' brief. The appellants' oscillograph is initially set so that as the same oscillates in accordance with the sound being recorded the zero line, with reference to which the oscillation occurs, would be in the middle of the sound track. This would result in about one-half of the sound track being transparent. However, appellants introduce into the circuit controlling the oscillograph, a source of constant direct current which moves the zero line to a position near one edge of the sound track. This results in substantially the whole sound track being blackened when no sound is being recorded. The oscillograph and the mirror carried thereby are caused to oscillate and produce the sound record by a sound-responsive alternating current. A portion of the incoming alternating current is rectified and acts in opposition to the previously mentioned direct current bias to move the zero line away from the edge of the sound track to a variable extent depending on the loudness of the incoming sound. This will produce a sound record of the character shown in appellants' Exhibit 1. It appears that appellants' rectified alternating current can do no more than cancel the effect of their initially applied direct current bias and therefore that the zero line of the oscillation cannot be displaced beyond the center line of the sound track. Appellants have shown in Fig. *d* of their Exhibit 3 (R. p. 118) an example of a sound record produced by their apparatus where the loudness of the sound produces oscillations passing beyond both edges of the sound track. It is appellants' contention that inasmuch as the zero line of the oscillations cannot be displaced beyond the midline of the sound track that the extremities of the oscillations will be equally cut off at both edges of the sound track and therefore no substantial distortion of the sound will be caused, even if the oscillations are not confined entirely to the sound track.

## THE HEWLETT AND ROBINSON PATENTS

In both the Hewlett patent, No. 1,853,812 (R. p. 60), and in the Robinson patent, No. 1,854,159 (R. p. 65), the same result is sought as in appellants' apparatus and method. As will be seen in Fig. 2 of the Hewlett patent the whole width of the sound record is blackened during silent periods. In the Hewlett device the oscillograph is so set initially that the zero line about which the oscillations occur is near one edge of the film. The alternating electric current enters through the wires 18, is suitably amplified by the amplifiers 22 and 25 and causes the mirror 10, carried by the oscillograph 11, to oscillate in accordance with the sound being recorded. A portion of the incoming alternating current is, as in appellants' device, rectified by the rectifier 30 and is applied to the oscillograph to move the zero line of its oscillations away from the edge of the sound track in accordance with the amplitude of the alternating current, that is, in accordance with the loudness of the sound being recorded. This obviously results in a sound record which is blackened during silent periods. It is appellants' contention that inasmuch as the zero line may be displaced beyond the middle of the sound track the device of Hewlett will produce a record of the character shown in Fig. *c* of appellants' Exhibit 3 (R. p. 118) in which for certain loud sounds only the tops of the oscillations extend beyond the edge of the film and are not recorded thereon. This, appellants contend, results in a distortion of the loud sounds.

The Robinson patent, No. 1,854,159 (R. p. 65) is so generally similar to the Hewlett patent that a specific discussion thereof is unnecessary.

## THE CLAIMS ON APPEAL

The claims on appeal are found in the record beginning on page 3 and also in appellants' brief beginning on page 17.

## SUMMARY OF ARGUMENT

The claims on appeal recite nothing involving invention over the disclosures of the Hewlett and Robinson patents, *supra.*

Claim 70 does not meet the requirements of Section 4888 R. S. (U. S. C., Title 35, Sec. 33).

## ARGUMENT

Appellants concede that claim 49 is met by either of the patents to Hewlett and Robinson except for the portions of the claim italicized in their brief. The first italicized portion of this claim appears to be vague as to what is the initial position of the "zero line" but it seems clear that in both Hewlett and Robinson the "zero line" does move into the center line of the sound track even though at times it may move beyond that position.

The Board of Appeals of the Patent Office did not discuss the second italicized portion of the claim but it would appear that the arrangement of the resistances set forth therein find their equivalents in the resistances 37 and 38 of Fig. 1 of the Robinson patent, and also the resistances 40 and 44 of the Hewlett patent.

Claim 70 has been held unpatentable as not meeting the requirement of Section 4888 of the Revised Statutes, that the applicant "shall particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery." The portion of the claim to which reference is had, which is deemed to be inaccurate and indefinite, is that which appellants have italicized in their brief. It was the view of the Examiner and of the Board of Appeals that the electrical constants of the rectifier and circuit are the same whether the rectifier is operative or inoperative.

The remaining claims on appeal, 72 ,73, 74, and 76 to 79, inclusive, may be considered together. Appellants have italicized the portions of these claims which they contend recite invention over the Hewlett and Robinson patents.

Claim 72 recites that the variations of the average exposure are held between predetermined upper and lower limits. It does not state what these limits are and the Board of Appeals was of the view that in devices of the Robinson and Hewlett patents there must be limits somewhere to the average exposure, and that the claim does not distinguish patentably from either of the patents.

Claim 73 states that the lower limit of the average exposure is approximately zero. This is clearly the case in Robinson and Hewlett, where substantially the whole width of the sound track is black during silent periods.

Claim 74 is more specific, reciting that the upper limit of the average exposure variation is substantially midway between zero and full exposure. This feature the Board considered to be merely an arbitrary restriction of the limits of average exposure variations, necessarily present in the Robinson and Hewlett devices.

Claims 76, 77, and 78 are so similar to claims 72, 73, and 74, respectively, that they need not be separately discussed.

Claim 79 has reference to the direct current bias which is initially applied to the oscillograph to bring the zero line to one edge of the sound track. Hewlett and Robinson accomplished the same result by initially mechanically adjusting the oscillograph so that the zero line of its oscillations would be at one edge of the sound track. This modification appears to involve no invention.

## CONCLUSION

It is therefore submitted that the judgment of the lower court should be affirmed.

W. W. COCHRAN,
*Attorney for Commissioner of Patents,*
*Appellee.*

SEPTEMBER 1939.

# APPENDIX

SEC. 4888 (U. S. C., title 35, sec. 33). Before any inventor or discoverer shall receive a patent for his invention or discovery, he shall make application therefor, in writing, to the Commissioner of Patents, and shall file in the Patent Office a written description of the same, and of the manner and process of making, constructing, compounding, and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, compound, and use the same; and in case of a machine, he shall explain the principle thereof, and the best mode in which he has contemplated applying that principle, so as to distinguish it from other inventions; and he shall particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery. The specification and claim shall be signed by the inventor. No plant patent shall be declared invalid on the ground of noncompliance with this action if the description is made as complete as is reasonably possible.

U. S. GOVERNMENT PRINTING OFFICE: 1939

[illegible]

FILED SEP 25 1939

Joseph W. Stewart

CLERK

IN THE

# United States Court of Appeals for the District of Columbia

ARNOLD POULSEN and AXEL CARL GEORG PETERSEN,
*Appellants,*

*vs.*

CONWAY P. COE, Commissioner of Patents,
*Appellee.*

No. 7380

## REPLY BRIEF FOR APPELLANTS.

PAUL KOLISCH,
*Attorney for Appellants.*

LAWYERS PRESS, INC., 165 WILLIAM STREET, NEW YORK CITY, N. Y.

IN THE

# United States Court of Appeals for the District of Columbia

---

Arnold Poulsen and Axel Carl Georg Petersen,
*Appellants*,
*vs.*
Conway P. Coe, Commissioner of Patents,
*Appellee.*

No. 7380

---

## REPLY BRIEF FOR APPELLANTS.

The Commissioner's brief assumes that the results sought by appellants and by prior inventors were the same. We find, for instance, on page 2 of the brief:

> "The end sought by appellants and by other and prior inventors is to avoid the background noise by *eliminating as far as possible the transparent areas.*" *

Again, in speaking of the Hewlett and Robinson patents, the Commissioner says on page 4 of his brief:

> "the same result is sought as in appellants' apparatus and method."

While the differences between appellants' invention and the prior art and the absence of any prior recognition of the problem solved by appellants has been fully discussed in our main brief, we shall point out the erroneousness of the above quoted statements because we fear that the decision of the Court below was based on the same misunderstanding.

---

* Italics ours throughout the brief.

Comparison of Figs. *c* and *d* of Exhibit 3 (R. p. 118) shows that while Robinson and Hewlett sought to eliminate as far as possible the transparent areas during silent periods, appellants departed from this practice and *increased* the corresponding transparent areas. In Robinson and Hewlett all the peaks are near the lower edge of the sound track. In appellants' structure the small peaks are near the *center* of the track whereby during silent periods the transparent areas of the Robinson or Hewlett type of record will be materially increased. By thus going counter to prior teachings, appellants have eliminated the asymmetric cut-off which Robinson and Hewlett had introduced into the art.

There is not a word of recognition of this problem in any prior patent. None of the prior patentees so much as suggested that some disadvantage may result from the reduction to a minimum of the transparent areas.

The Commissioner argues (p. 7) that the claims are met because in Robinson and Hewlett there is a definite lower limit and there must be *some* upper limit to the average exposure.

The essence of the invention as expressed in *all* the claims is that there be not only a definite lower limit and some vague upper limit, but that both the lower and the upper limits of the displacement of the zero line be PREDETERMINED. The Commissioner admits that the upper limit in the prior disclosures is *not* predetermined for, as he says (p. 6):

> "in both Hewlett and Robinson the 'zero line' does move into the center line of the sound track even

> though *at times it may move beyond that position.''*

This displacement beyond the center line occurs when extra loud sounds are recorded and the sole object of the invention in issue is to avoid such movement of the zero line past the center. The Robinson and Hewlett disclosures could not be modified to prevent the movement of the zero line past the center line, and since none of these highly skilled prior inventors recognized even the advisability of preventing such excessive displacement of the zero line, the conclusion seems inevitable that appellants have made an invention of great merit.

In addition to the limitations concerning the displacement of the zero line, claim 49 defines a specific arrangement of the resistances which, as was pointed out in our main brief (pp. 18-21), does not find its counterpart in Robinson and Hewlett as asserted by the Commissioner (p. 6).

The Commissioner offers no explanation why claim 70 is inaccurate and indefinite, nor why specific claims like 74 and 79 are unpatentable over art which concededly does not even disclose the broad concept of claim 72.

As to the allowance of a number of claims in the application to which the Commissioner makes reference (bottom of p. 2 of his brief), we again call attention to Mr. Poulsen's testimony (top of p. 90) that the claims allowed in the application have nothing to do with the invention in issue.

Typical for the claims allowed is claim 65 (R. p. 27) which, after describing the customary prior art structure, calls for such an arrangement of the circuits by means of which the displacement of the zero line is controlled

> ''that the rate of decrease of the current acting upon the recording means is greater during in-

> crease of the sound intensity than the rate of increase of the peak value of the alternating current."

Referring to Exhibit 3 (R. p. 118) Fig. *d*, this is shown by the steeper rise of the zero line in the left-hand portion, that is to say, when the sound amplitudes increase, than in the right-hand portion, *i. e.*, when the sound amplitudes are decreasing. The allowed claims have nothing whatever to do with the asymmetric cut-off or with the upper or lower limits to the displacement of the zero line.

## *Conclusion.*

In conclusion it is submitted that the denial of a patent to appellants is based on nothing more substantial than prior patents in which one can find not even a vague disclosure nor a suggestion of this meritorious invention.

Respectfully submitted,

PAUL KOLISCH,
*Attorney for Appellants.*

New York, September, 1939.